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A thesis in Historic Preservation Presented to the Faculties of the University of Pennsylvania in Partial Fulfillment of the Requirements of the Degree of Master of Science in Historic Preservation 2008. Advisor: Michael C. Henry

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The Development of Precast Exposed Aggregate Concrete Cladding: The Legacy of John J. Earley and the Implications for Preservation Philosophy

Abstract

This thesis seeks to explore the development of a building material with regards to its durability and production. It does so in the examination of the advances in material understanding and technique with regards to a unique twentieth century material – precast exposed aggregate concrete. Tested, refined and later patented by craftsman John J. Earley, the precise process of creating exposed aggregate concrete cladding (today known as the MoSai technique) holds unique implications for its preservation. Analyzing what Earley - and those who helped refine the MoSai process over the years - understood with regards to the material's properties will determine whether the material's evolved production has preservation implications inherent to the process. The way in which Earley approached perfecting precast exposed aggregate concrete paneling will also assert his place in architectural history beyond the development of a durable, permanent material; his Earley Process has had lasting influences on today's standards and production – separating today's materials from their traditional predecessors and thus, potentially affecting how preservationists view all modern materials as they ready themselves for the future of their work.

Disciplines

Historic Preservation and Conservation

Comments

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EXPOSED AGGREGATE CONCRETE CLADDING:
THE LEGACY OF JOHN J. EARLEY AND
THE IMPLICATIONS FOR PRESERVATION PHILOSOPHY**

JENNA CELLINI

A THESIS

in

Historic Preservation

Presented to the Faculties of the University of Pennsylvania in Partial
Fulfillment of the Requirements of the Degree of

MASTER OF SCIENCE IN HISTORIC PRESERVATION

2008

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to my family,
especially my parents,
who encouraged me to always look for
the art in science
and the science in art

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CHAPTER 1: INTRODUCTION

This thesis seeks to explore the development of a building material with regards to its durability and production. It does so in the examination of the advances in material understanding and technique with regards to a unique twentieth century material – precast exposed aggregate concrete. Tested, refined and later patented by craftsman John J. Earley, the precise process of creating exposed aggregate concrete cladding (today known as the MoSai technique) holds unique implications for its preservation. Analyzing what Earley - and those who helped refine the MoSai process over the years - understood with regards to the material's properties will determine whether the material's evolved production has preservation implications inherent to the process. The way in which Earley approached perfecting precast exposed aggregate concrete paneling will also assert his place in architectural history beyond the development of a durable, permanent material; his Earley Process has had lasting influences on today's standards and production – separating today's materials from their traditional predecessors and thus, potentially affecting how preservationists view all modern materials as they ready themselves for the future of their work.

When it comes to the preservation of older buildings, preservation professionals are guided by specific mandates to preserve and maintain the site's original fabric, since great value is placed on the integrity of the original materials. The refinement of the conservation programs has been based on the importance of the site: as an icon of a lost technology, the use of a natural material no longer widely used, or a level of craft and genius that officials find vital to the history of architecture. However, where does this place preservation when

professionals must work with modern buildings and modern materials, such as exposed aggregate concrete? These buildings are not archaic, materials of a lost craft or process. Furthermore, twentieth century building materials are more complex than their predecessors, in manufacturing processes, standards, and the availability and range of testing methods. Modern materials are often composite materials manufactured using large scale and mechanized processes. Thus, understanding the Earley Process will inform this analysis on precast exposed aggregate concrete paneling and its potential pathologies, concluding with recommendations for the most appropriate efforts in light of current preservation guidelines.

Studying the historical development and early testing of building materials such as this one is essential in “guarding the integrity of twentieth century architecture and limiting insensitive repairs and replacements.”¹ Precast exposed aggregate concrete is a high-craft, massed-produced material whose production process is regulated by a specific set of standards and specifications, which in turn, are supported by empirical scientific studies. The scientific analysis and mass production of such building components is at the heart of the development of modern materials, and since these processes are a direct shift away from their traditional ancestors, the philosophical debate for the preservation of such architectural features is lacking. This work is intended to promote awareness of the history of precast exposed aggregate concrete cladding to determine the appropriate steps for its conservation.

Although the idea did not originate with him, John J. Earley was the man truly responsible for developing exposed concrete as both a decorative architectural feature and a

¹ Thomas C. Jester, “Preface.” *Twentieth Century Building Materials: History and Conservation*, (Washington, DC: Library of Congress Publication, 1995), 9.

technically refined manufactured building material. In 1940 he patented his process for producing these precast elements which was later coined it “MoSai” – an interesting term that recognizes the artistic, craftsman-quality of this product. With this first step, Earley set three standards. First, identifying his technique in reference to the art of producing mosaics, Earley added a unique facet to his material that many people outside the field would simply call “concrete;” he immediately recognized the Modern Movement’s idea of “playing” with building materials and experimenting with their ability to express an architect’s desired aesthetics. Secondly, in patenting and later publishing and sharing his work, Earley initiated the professionalization and standardization of producing and applying precast exposed aggregate concrete. Today, this material, as well as other modern materials, is mass-produced within a framework of standards under provisions of professional organizations such as the Portland Cement Association (PCA) and the American Concrete Institute (ACI, of which John J. Earley was president in 1938). Finally, through continual efforts, Earley led the field’s revolutionary approach to material studies and design; it was through him that architects and material scientists of the AIA (American Institute of Architects) and ACI formed a mutual cooperative to develop and fashion building construction that would later dominate the latter part of the twentieth century in America.

The MoSai or Earley Process was a unique technique that became the predecessor for how other modern materials later developed. Earley based the process on his understanding of the product: its material components and their fabrication and assembly combined with his belief of the product’s imperative role in American architecture. However, how much did Earley really know about the material? Was durability of the product an essential characteristic in the technique? Has the MoSai technique been altered to

incorporate advancing knowledge of the material, aiding in its durability and service life? Or did Earley know so much about the material that there was nothing left to learn and implement into the design in terms of the material's durability and longevity? Also, how has this influenced our understanding and the study of modern materials and their preservation in general? As these "modern" buildings approach the age where they can be nominated as heritage sites, an understanding of the techniques of material makeup and design are at the front of the issues faced by preservation professionals.

To analyze the ideas set forth, this thesis studies the history of precast exposed aggregate concrete through the ideas and works of its father, John J. Earley. The analysis begins with detailing the development of the use of precast architectural concrete in the United States. It describes concrete's development from one of a basic, cheap engineering material hidden behind stucco in the nineteenth century to its presence on the very face of Modern architecture as a decorative feature in unprecedented uses. The work then narrates the evolution of the material up to and including John J. Earley's efforts to standardize and professionalize the manner in which the material was produced. It profiles the development of Earley's patented MoSai Process to produce the unique attributes of exposed aggregate concrete known artistically as concrete mosaic cladding. It describes what was/is known about the material and if the process accounts for weatherability and durability – both in its initial uses and today. It then continues to chronicle the use of Earley's technique into the mass production industry of the latter twentieth century to identify Earley's lasting influences on the architectural world. Finally, with the gathered information, an evaluation is made as to the relationship among the material's production and durability, to assess the adequacy of current preservation policies and to identify what conclusions can be made for

future preservation efforts. By identifying the evolving knowledge of material characteristics and performance and the specific material production from its earliest attempts to its current state as an architectural cladding element produced by wholesale manufacturers, an evaluation can be made as to how preservationists practice with this specific material. However, a review of the current literature available on the subject must be discussed first in order to provide a framework before any historical or philosophical analysis can begin.

CHAPTER 2: LITERATURE REVIEW

INTRODUCTION

The following literature review provides the framework and background research for this thesis. Since this analysis is the combination of several distinct, definable subjects, the chapter has been subdivided into the following: the Modern Movement; Technology: both the historical and preservation aspects of precast exposed aggregate concrete; and Preservation Philosophy. This review begins with a discussion about recent preservation literature that prompted thought toward conducting research on a modern material. It is a general understanding of the turn of events that led to a desire to analyze the preservation efforts of modern architecture. Furthermore, it defines the qualities unique to modern heritage, providing a structure within which to analyze Earley's work. After this, a history of the development of precast concrete from a mere building block to an important aesthetic component in American architecture will set the stage for the analysis of the evolving understanding and production of precast exposed aggregate concrete in the mid-twentieth century. Finally, preservation philosophy places the analytical information presented in this thesis within a specific context of preservation thought – from which conclusions and recommendations can be drawn.

THE MODERN MOVEMENT

The past two decades have seen the emerging debate over preservation of the Modern Movement. A paper recently published by the National Trust Council tries to identify the current issues involved with preserving modern American architecture. As Paul

Goldberger writes, one of the main debates over the conservation and preservation of modern architecture is that architecture of this time period is mostly vernacular, mass-produced buildings for everyday use where the architect, in order to sell his design to clients, stressed functionality over artistic quality and creative design.

To a lot of us many modernist buildings are not only too new; they are also too ordinary, too everyday. They don't seem to have about them the aura of true works of art...So many of the modern buildings that are now threatened – the libraries, the schools, the airports, the office buildings – seem like run-of-the-mill products of a time that all of us know was not the high point of Western architecture. So once again the question stands there, hovering over us: Why? ²

Goldberger continues to argue, however, that although the twentieth century saw the rapid construction of countless, faceless buildings, those structures that *define* the Modern Movement were about experimentation, the architect's ability to try new designs with new materials. The ability of these designers to push the boundaries of architecture of their time was a direct result of the advancing technology in building material manufacture and production – namely, the rise of the machine – of the twentieth century.

It was not half as practical as it claimed to be, or as it claimed to be when it was convenient to make such claims. It was often not practical at all. Glass, floating planes, blurring the distinction between inside and outside, turning rooms from distinct entities into flowing space – you could make all the functionalist arguments you want for such things, but at the end of the day they were aesthetic choices, not functional ones. The better architects knew it. The lesser ones didn't, and used functionalism as an excuse for mediocrity, but that is not the architecture that we are talking about, by and large, when we talk about modernist preservation. We are talking about those buildings – and there are many of them – that represented a new vision of the world, a world inspired by the image as well as the reality of technology, a world of

² Paul Goldberger. "Modernist Preservation: Why Should it Matter?" (National Trust Council Papers, 9 November 2007).

possibilities created first by the machine, and now, in later generations of modernism, by the computer. It is now much more than a century since all of these things began to create a new aesthetic, and the value of that aesthetic, not to say its beauty, ought to be beyond doubt at this point.³

The quality of work produced at this time was a direct result of the developing technology of the time, and this interplay of technology and aesthetics in modern architecture stimulated refined techniques of material production and application; this correlation spurred thought about developing a thesis that discussed the vital role of technology in the production of modern architecture.

Goldberger's argument continues to discuss the aesthetic importance of modern architecture; however, it never mentions how the advanced technology of the time led to an assurance of a specific quality and durability of building construction for the first time in the history of architecture. The mass production of building components within factories based upon a standard set of specifications led to the ability to create both aesthetically-appealing and functionally-sophisticated structures. With that said, can't the juxtaposition of aesthetics and advanced material understanding and production become a valid argument for modern architecture's preservation? Although aesthetics and the time-based argument are presented in Goldberger's article, the exclusion of an argument based on a building's durability, what was known about the material and how that influenced its production, led to the desire to analyze the conservation philosophy of the technical aspects of modern materials in this thesis. A key question developed from reading this report: Would it be just as convincing to argue the preservation of modern sites because of their durability in construction as it is based on their aesthetic value?

³ Ibid.

The interplay of durability and production of twentieth century buildings is especially evident in the development of post-war concrete structures, particularly concrete cladding structures – a significant number of which may someday warrant preservation. As Michael Bussell explains in his article “The Use of Concrete in the Post-War Era,”

Early post war use included the cladding panels of prefabricated housing from which developed the much wider use of concrete cladding as the outer leaf of the building envelope. Precast cladding had the advantage that it could be made under factory conditions to a consistent quality, and inspected and approved before it was incorporated into the building.⁴

Bussell cites one of the major shortcomings of the experimentation of modern architecture and materials that affects the current state of preservation; namely, that this experimentation coincided largely with a lack of understanding and experience with certain materials. He states,

The rapid and large-scale adoption of concrete after the war meant, perhaps inevitably, that designers and builders did not always have the experience needed to ensure successful performance. Codes of practice for design and construction were either out of date or non existent. And in some respects, notably durability and differential movement between building materials, there was a lack of understanding of the issues.⁵

Durability in terms of steel corrosion and concrete cracking/spalling was less likely to occur if the concrete cover was thicker, denser, and less porous. Regrettably, this knowledge was, at best, thinly spread in the years after the war.⁶

⁴ Michael Bussell, “The Use of Concrete in the Post-War Era,” *Preserving Post-War Heritage: The Care and Conservation of Mid-Twentieth Century Architecture*, (Shaftsbury, Dorset: Donhead, 2001), 97.

⁵ Ibid, 99.

⁶ Ibid, 100.

Was Earley's work within this "lack of knowledge"? What did Earley know that other material producers did not, allowing him to lead the standardization and durability of concrete cladding in the mid-twentieth century? Insight into his understanding as to the refinement and standardization of concrete cladding production is necessary in understanding how preservationists should approach these structures.

With the advanced efforts of organizations such as DOCOMOMO and English Heritage, the preservation of modern concrete architecture is being recognized and gaining support. Much research has been developed by these two groups in terms of advanced understanding of the deterioration of reinforced concrete and current conservation methodologies. In her article, "Reconciling Authenticity and Repair in the Conservation of Modern architecture," Susan MacDonald attributes the recent success of modern preservation to the standardization in the production of modern materials, which she claims allows for a better grasp of dealing with their conservation.

One of the characteristics of modernism is its attempt to standardize construction for prefabrication to provide a new infrastructure on a larger scale, globalizing rather than regionalizing the resulting architectural expression: this has a great advantage in conservation terms by enabling us to deal with the philosophical and physical conservation problems on a larger international scale, helped by improved communications systems.⁷

Thus, the post-war production of modern materials not only provided standards to which building components were designed, but the globalization of such methods has eased the ability of preservationists across the globe to develop general guidelines and principles for

⁷ Susan MacDonald, "Reconciling Authenticity and Repair in the Conservation of Modern architecture," *Modern Matters: Principles and Practice in Conserving Recent Architecture*. (Shaftesbury, Dorset : Donhead, 1996).

modern conservation efforts. However, how well do these recommendations apply to specific applications of precast concrete?

One such application is the recent concern for precast exposed aggregate concrete structures. An article in the DOCOMOMO newsletter from Spring 2007 urged the preservation of Paul Rudolph's Blue Cross Blue Shield Headquarters in Boston's Financial District by citing its unique use of a specific type of precast concrete cladding, known as "MoSai."

The fourteen story tall building is clad in an innovative system of articulated exposed aggregate "MoSai" precast concrete panels that both hold all the perimeter mechanical systems and give a striking and muscular character to the facades. In style and material it is an important forerunner of many works of the late 1960s and early 1970s, including the Peter and Alison Smithson's Economist Group in London. As pointed out by Timothy Rohan in an article in the March 2007 issue of the *Journal of the Society of Architectural Historians*, Rudolph's response to the site and program are surprisingly contextual and establish an interesting alternative to the metal and glass curtain wall construction that characterized most office buildings of the 1950s. Rohan clearly establishes the significance of the BC-BS building placing it firmly in the orbit of the earlier postwar explorations of August Perret, Le Corbusier and particularly the structural expression and façade treatment of the curtain wall at BBPR's Torre Velasca in Milan as an important component of the larger critique of International Style modernism that was occurring in this period.⁸

This article led to further inquiry about the historical roots of this particular concrete cladding. Where and how did this "MoSai" technique develop? And how does this specific technique of producing of precast exposed aggregate concrete fit into the philosophy of preserving post-war heritage? Furthermore, what does this specific process mean in terms of material durability and, thus, can its durability be a basis for its preservation?

⁸ David Fixler, "Early Paul Rudolph Building Endangered," *DOCOMOMO Newsletter*, Spring 2007, 3.

TECHNOLOGY

History of Precast Exposed Aggregate Concrete

Historical research into the MoSai technique led back to the beginning of precast architectural concrete in America – thanks mainly to the efforts of John J. Earley and the American Concrete Institute. One of the first articles found through the American Concrete Institute concerning both precast architectural concrete and John J. Earley was one of his own writings for *ACI's Journal Proceedings*. An understanding of Earley's mindset while developing the specific technique that would be later known as "MoSai" can be seen in his 1939 article "On the Work of the Committee on Architectural Concrete of the Exposed Aggregate Type and the Thomas Alva Edison Memorial Tower." This article elucidates three things: Earley's belief in the superiority of this particular material – namely, how architectural concrete was not "structural concrete elevated to the level of an artistic medium [but rather] an artistic medium extended to a more general use... acceptable to the architect;"⁹ the amount of material investigation Earley had already undertaken in order to understand the physical properties of concrete as it pertains to exposed aggregate precast cladding; and Earley's desire to not only standardize the production of this material but to share this method with other producers, architects and craftsmen – thus, professionalizing the production of precast exposed aggregate concrete. Earley urges,

I think we should stop making a mystery of craftsmanship and get down to the precise details of what and when and how and why, then we will have something to give to the world which will be a real foundation for more of the same...The work when finished must conform to a pattern of general

⁹ John J. Earley, "On the Work of the Committee on Architectural Concrete of the Exposed Aggregate Type and the Thomas Alva Edison Memorial Tower.," *Journal of the American Concrete Institute* 34 (May 1938): 590.

policy designed by the Board to extend to persons who can be benefited by it.¹⁰

He references ACI's development of Committee 412 for the scientific research and study on the durability and performance of concrete in all its forms. This was the turning point for the production of modern concrete and the way in which all modern materials would later be tested, developed and standardized.

This article was one of Earley's last writings during his forty years of work. From 1915 to 1940, Earley wrote a little less than twenty articles for ACI's journal. Although a craftsman by nature, he understood the science of concrete and published whatever findings he uncovered. The collection of his writings will provide a framework for piecing together Earley's refined production.

Others expressed interest in precast exposed aggregate concrete; among them, sculptor Lorado Taft and, naval engineer, Hugo Fischer added insight into the evolving understanding, production and use of the material, and more particularly, the Earley Process. Their work with precast architectural concrete and their connection to Earley's development of the MoSai technique can be analyzed through their published writings found in ACI's journal and committee proceedings.

After Earley's aggressive work of the 1930s, studies and research on precast exposed aggregate concrete did not re-emerge until the 1950s and 1960s when the American Concrete Institute and the Portland Cement Association published standards and general

¹⁰ Ibid: 589.

production and application guidelines. These documents offer specific techniques to ensure high early strength and durability of concrete, namely through accelerated curing, limits for air content, the water to cement ratio, cement content, and rebar spacing.¹¹ Since the publication of these documents allowed the cladding components to be mass-produced by many companies around the country, scientific research was published alongside these references to validate the material's durability or provide recommendations for improving its performance. A vital study developed in 1963 identified both what was known already about the material in terms of durability and what was still needed for improved resistance to weathering.

The addition of air-entraining agent in normal amounts to a harsh, high strength concrete mix such as is generally used in exposed aggregate panels significantly improves the frost resistance of the exposed aggregate concrete even though small amounts of air is usually entrained.¹²

If and how this affected the MoSai production of precast exposed aggregate concrete will be discussed in determining what Earley had done in the 1930s and what the Earley Studio continued after his death and into the 1950s and 1960s.

A seminal text for the way architects and material scientists developed precast exposed aggregate concrete in the 1960s is J. Gilchrist Wilson's *Exposed Concrete*. His work immediately establishes durability as one of the main goals in developing exposed concrete – together with color and texture, identifying that “a recent examination of a large number of

¹¹ Arsham Amirikian, “Tentative Recommendations for Thin-Section Reinforced Precast Concrete Construction,” *Journal Proceedings of the American Concrete Institute* 29, no. 11 (May 1958): 921 – 928.

¹² A. W. Isberner, “Durability studies of exposed aggregate panels,” *Portland Cement Association, Research & Development Laboratories Journal* 5, no. 2 (May 1963): 22.

buildings already faced with exposed aggregate panels indicates that their weathering qualities are quite satisfactory.”¹³ He continues to emphasize the industry’s growing shift from individual, small shop to factory-based production and offers advice on how to achieve the same, hand-crafted effect that was done by the earlier craftsmen.

It is appreciated that the industrialization of production methods calls for a simplification of finishing techniques and the individual treatment that many firms give their exposed aggregate products may have to give way to mass production techniques; in the USSR it has been found that the most economical method of producing exposed aggregate finishes is by passing the slabs under electrically driven steel brushes.¹⁴

Wilson believes that the refined, hand-crafted technique implemented by Earley can be achieved on the larger scale; however, the actual application of this idea in post-Earley structures will be analyzed to identify what lasting influences John J. Earley and the Earley Studio had on the production of concrete cladding in the latter part of the twentieth century.

Design and production standards for thin precast concrete cladding were continually updated for the advancing knowledge and technology of the latter portion of the twentieth century. However, since standards in the production of exposed aggregate cladding were already published and had scientific tests to validate the recommendations provided in the standards, literature on this specific material shifted from design specifications to historical research. In the late 1970s up until today, researchers have focused more on the historical roots of concrete in America. This can be attributed to the aging of earlier twentieth century works, such as Earley’s structures of the 1920s and 1930s. Current literature is aimed at

¹³ J. Gilchrist Wilson, “Chapter 4: Cladding,” in *Exposed Concrete Finishes*, Volume II: Finished to Precast Concrete, (New York: John Wiley & Sons Inc, 1962), 95.

¹⁴ Ibid.

understanding how concrete developed into the wide-spread material it is today and how it achieved its elevated status in modern American architecture.

One of the main texts of this time, A.E.J. Morris's *Precast Concrete in Architecture* traces precast concrete from its origins in France to its development throughout the rest of Europe and America. Although this work encompasses all uses of concrete, it identifies the trends in the development of exposed-aggregate finishes. One interesting remark by Morris in the book reflects his opinion of the work of the American Concrete Institute during Earley's efforts; that is, "a *mature* understanding of practically all current surface finishes had been reached in the USA by the first half of the twentieth century."¹⁵ What Morris meant by "mature" and whether he was directly referencing Earley is unknown, but based upon his studies, Morris believed that those that studied exposed aggregate concrete facing in the earlier half of the twentieth century had such an advanced knowledge of their material that their techniques needed little refinement later. The validation of this belief will be proven in the analysis of what Earley had known at the time and what he discovered through his empirical scientific research.

An interest in concrete's history and development in America led a handful of writers to study the works of John J. Earley – above all was engineer and historian Frederick Cron. After retiring from the U.S. Bureau of Public Roads, Cron devoted much of the 1970s to studying John J. Earley and the Earley Studio. His book, *The Man Who Made Concrete Beautiful*, narrates Earley's most visible works up until his death in the 1940s. Cron's research mirrors other writings of the time: James Mann's "A Pioneer in the Use of Exposed

¹⁵ A. E. J. Morris, *Precast Concrete in Architecture*, (New York : Whitney Library of Design, 1978), 90.

Aggregate Concrete,” T.W. Hunt’s “Precast Concrete Wall Panels: Historical Review,” Richard Steiger’s “John J. Earley: Architectural Concrete Pioneer,” Lori Aument’s “Construction History in Architectural Conservation: The Exposed Aggregate, Reinforced Concrete of Meridian Hill,” and Sidney Freedman’s “History of Exposed Aggregate (MoSai) Architectural Precast Concrete.”¹⁶ Although these works identify the series of events that led Earley and his Studio to create the artistic form of precast concrete in the 1930s, they do not follow up on the continuation of the Earley Studio or on the development of the widespread use of the MoSai technique Earley had patented shortly before his death. Cron’s archived collection, currently housed at Georgetown University, attempts to track the Earley Studio throughout the 1950s and 1960s with various journal articles and newspaper clippings. However, this piecemeal collection and the other writings do not connect Earley’s efforts with the later legacy of precast exposed aggregate concrete cladding. This gap of information is what directed this thesis toward a historical analysis of the MoSai technique before, during and after John J. Earley and to determine Earley’s legacy on the production of precast exposed aggregate concrete.

In terms of the durability of precast exposed aggregate concrete cladding of the mid-twentieth century, only a couple of articles mention its weatherability and durable performance, and even less scientifically analyzes the material. These studies are namely due to the efforts of international and national organizations such as DOCOMOMO and the Portland Cement Association. The most recent work adds to the study of what Earley knew in terms of material performance and how that aided in the development of the MoSai technique. PCA’s “Performance of Architectural Concrete Panels in the PCA Outdoor

¹⁶ Refer to the Bibliography section of this report for the full citations of these works.

Display” studies sets of precast exposed aggregate concrete panels from the 1930s (Earley’s period of production). After withstanding cyclic weather patterns of over seventy years, the panels are analyzed and assessed in terms of their durability, cohesion and aesthetics.¹⁷ Analyzing PCA’s assessment of the panels will not only determine how its original production in the first part of the twentieth century led to its level of durability but will provide evidence to either support or deny the assertion that the juxtaposition of aesthetics and durability makes Earley’s work worthy of preservation.

Preservation of Precast Exposed Aggregate Concrete

Since the history of concrete in America has been researched thoroughly in the last decades of the twentieth century, the current body of literature with regards to precast concrete cladding deals primarily with its restoration. The National Parks Service has led the country in developing general recommendations and strategies for dealing with historic concrete conservation. Most studies advocate repair of minor concrete damage, especially if the deterioration may cause future structural problems for the structure.¹⁸ However, these writings do not grapple with the preservation theories or philosophies that would either justify or nullify these recommendations or whether or not these guidelines are adequate for Earley’s precast architectural concrete.

John Streeter explains in his article, “Mosaic-Clad Concrete: Recent Research,” that conservation efforts are determined according to the desire to preserve the aesthetics of a

¹⁷ William C. Panarese, Albert Litvin, and James A. Farny. *Performance of Architectural Concrete Panels in the PCA Outdoor Display*, (PCA Publication: Skokie, IL, 2005).

¹⁸ William B. Coney, “Preservation Brief 15: Preservation of Historic Concrete: Problems and General Approaches,” *National Park Service Preservation Briefs*, (Washington, DC: Department of the Interior, Sept. 1987).

structure, without much detail or concern as to the long-term preservation of a building's materials or details. Based on his research, "publications concerning modern mosaics and mosaicists unsurprisingly tend to concentrate almost exclusively on either the aesthetic issues or the artistic interpretation rather than inform the reader about materials, techniques and technical details."¹⁹ Streeter identifies the major shortcomings of current preservation efforts with concrete used specifically for cladding.

With very few options, the usual approach to mosaic repair on modern buildings has been either to strip it off entirely and replace with an alternative material, or to over clad the existing surface after installing a stabilizing mesh or other restraint structure. This radically alters the appearance of the building...and given the present-day views on the ethics of conservation, these are not acceptable remedial options or certainly cannot be considered appropriately permanent solutions for defects in the long term.²⁰

This paper identifies Streeter's understanding of the lack of philosophical debate and preservation analysis necessary to elucidate the proper response to the care and conservation of concrete cladding; however, the article stops there, without Streeter offering professional insight into the debate. Therefore, this thesis will analyze preservation philosophy in order to find a suitable course of action for the care of concrete cladding – particularly, precast exposed aggregate concrete panels.

Only a few specialists have mentioned specific types of concrete use, such as exposed aggregate cladding, in their work. This is probably due to the lack of experience professionals have had with specialized concrete, such as Earley's work. However, some companies and organizations are gaining insight as Earley's most distinguished works are

¹⁹ John Streeter, "Mosaic-Clad Concrete: Recent Research" in *Modern Matters: Principles and Practice in Conserving Recent Architecture*. (Shaftesbury, Dorset: Donhead, 1996).

²⁰ Ibid.

becoming an advancing topic in the preservation field. The most recent publications dealing with the preservation of precast exposed aggregate concrete cladding deal with Earley's works; most of the studies use the historical research of the late twentieth century to replicate Earley's mosaic cladding. *The Armbruster Company* is one such firm that has replicated Earley's work in the restoration of both the US Marine Corps Memorial and the Baha'i Temple in Wilmette, IL.²¹ Using the information provided by the Earley Studio and the scientific analysis performed on Earley's existing structures, the company was able to successfully replicate and restore the sites back to their initial construction. Replication of Earley's mix is currently the most widely accepted and used conservation efforts on his other works, such as the Nashville Parthenon and as proposed for the Edison Memorial Tower.²² However, is this action in accordance with today's preservation standards and philosophies? Would Earley approve of such actions? This thesis will try to analyze the current efforts with regards to Earley's work to determine whether they meet the current preservation theories. If they are not suitable, this work will then try to identify what steps are necessary to preserve Earley's structures in accordance with current preservation philosophy.

PRESERVATION PHILOSOPHY

With the increasing number of modern structures that are endangered and/or becoming recognized in terms of their historical importance, an evaluation should be made as to where precast exposed aggregate concrete and the efforts of John J. Earley are placed within this context. The National Park Service, while attempting to provide guidelines for

²¹ The Armbruster Company. *Replication of Historic Exposed Aggregate Concrete*. (US Marine Corps Memorial, January 2004).

²² Ilene R. Tyler, "Replicating the John J. Earley Concrete Mix to Restore the Nashville Parthenon," *APT Bulletin* 35. (2004): 43-50.

rehabilitation and preservation projects, has led the preservation world in outlining criteria to assess what “significant modern architecture” exactly is. This organization clearly identifies modern architecture as the following:

The quality of significance in American history, architecture, archeology, engineering and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association with... that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master or that possess high artistic values or that represent a significant and distinguishable entity whose components may lack individual distinction.²³

An analysis of the qualities specific to John J. Earley’s technique and the implications of using such material will aid in identifying the validity of its preservation. However, understanding *why* Earley’s work should be saved as an icon of the development of American building construction practices is only the first step. *How* to approach this specific material with regards to conserving and maintaining a historical site with this particular material must be analyzed against current philosophical trends and standards.

This thesis seeks to examine how preservationists should approach the conservation of precast exposed aggregate concrete structures; namely, this work will seek to answer the question: restore, repair or replace? According to the *Burra Charter*, “conservation means all the processes of looking after a place so as to retain its cultural significance. It includes maintenance and may according to circumstances include preservation, restoration, reconstruction and adaptation and will commonly be a combination of more than one of

²³ Marcella Sherfy, and W. Ray Luce, National Register Bulletin: Guidelines for Evaluating and Nominating Properties that Have Achieved Significance Within the Past Fifty Years, (Washington, DC: US Department of the Interior, National Park Service, 1998), 17.

these.”²⁴ How does this general statement apply to modern American architecture and, specifically, Earley’s concrete structures of the mid-twentieth century?

Since their inception in 1976, *The Secretary of Interior’s Standards for the Treatment of Historic Buildings* have served as the backbone for preservation efforts in America for the past three decades. This thesis seeks to examine these standards as they can/will apply to precast exposed aggregate concrete cladding and will try to answer the debate: restore, repair or replace? Above all other recommendations, the *Standards for Rehabilitation* stress that “the historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.”²⁵ If possible, the actual physical remains that make the architecture worthy of preservation must be saved and maintained. Furthermore, “distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.”²⁶ The standards continue to explain other alternatives if the first two cannot be accommodated.

Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.²⁷

²⁴ ICOMOS Australia, Charter for the Conservation of Places of Cultural Significance (The Burra Charter), (Sydney: Australia ICOMOS, 1999).

²⁵ W. Brown Morton, III, Hume, G.L., Weeks, K.D., and Jandl, H.W., *The Secretary of the Interior’s Standards for Rehabilitation and Illustrated Guidelines for Rehabilitating Historic Buildings*. (Washington, DC: US Department of the Interior, 1992), no. 2.

²⁶ Ibid, no. 3.

²⁷ Ibid, no. 6.

This guideline becomes an interesting case when taking precast exposed aggregate concrete of the MoSai technique into consideration. How does this material's production validate or nullify these recommendations? An analysis of the guidelines will become especially important once Earley's practices and the evolution of the MoSai technique are fully explored.

The question over "restore, repair, replace" of precast exposed aggregate concrete also elucidates another philosophical debate: that of "authenticity." When it comes to the restoration of cultural heritage, the *Venice Charter* urges preservationists to maintain "the full richness of their authenticity."²⁸ However, what exactly does the term "authenticity" mean? When Earley's concrete mosaics were developed under the Earley Studio's control, how valid is replacement with the current method of producing such cladding: that is, mass production within a factory? Based on how today's precast industry incorporates the Earley Process, certain recommendations can be made as to how to appropriately preserve and restore the works completed *and later influenced* by John J. Earley.

CONCLUSION

The preceding literature review is by no means a full representation of the complete body of literature and research that has been consulted and incorporated into this thesis. However, it provides the framework for the research, analysis and conclusions on the development of precast exposed aggregate concrete presented in the following pages.

²⁸ ICOMOS, *International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter)*, (Venice: ICOMOS, 1966).

CHAPTER 3: THE DEVELOPMENT OF PRECAST CONCRETE IN AMERICA

What about the concrete? It was the cheapest (and ugliest) thing in the building world. It lived mostly in the architectural gutter as an imitation of rock-faced stone. Why not see what could be done with that gutter rat? Steel rods cast inside the joints of the blocks themselves and the whole brought into some broad, practical scheme of general treatment, why would it not be fit for a new phase of our modern architecture? It might be permanent, noble, beautiful.

~ Frank Lloyd Wright, in an interview, 1928

No, it is concrete which is the most noble of materials – it is immortal: instead of disintegrating with age, it hardens with age. See for yourself; go to Rome and try to break old Roman concrete with an axe; you will only dent the steel.

~ August Perret, in an interview, 1960

INTRODUCTION

History has shown that the development of a nascent building material or construction method typically follows a general series of events: first, the material or method is generated from historically accepted practices. Then, through experimentation and innovation, it develops into its own material, capable of satisfying designers' intentions that were, beforehand, not possible. The development of proprietary and patented processes follows this period of constant empirical testing and refinement. This act of protecting the material and its method of production through copyright laws leads to the later formation of industry-wide organizations, who are left the stewards responsible for promulgating industry consensus standards and thereby, enabling industry-wide use with an acceptable level of risk.

This natural progression of events is evident in the birthing and growth of precast concrete in America. In order to understand the development of the American precast

paneling industry as made famous by the Earley Studio, the evolution of precast concrete must begin with the development of concrete as a construction material. This chapter seeks to outline the growth of this material and its manufacturing process prior to the work of the Earley Studio. It begins with the rise of the machine and advanced technologies during the nineteenth century's Age of Industrialization in Europe, which enabled cement – a vital component of concrete – to be produced (naturally and artificially) worldwide. The chapter then describes how this global production stimulated a few innovators in Europe to formulate new ways to form and utilize concrete. Tracing this burgeoning of new concrete production methods and materials in Europe during the nineteenth century provides the necessary framework for Earley's work: for it was the combination of Britain's beginnings with precast paneling and France's experimentation with architectural concrete that eventually leads to America's use of both techniques in the final formation of precast architectural concrete. However, before the development of precast can be explained, the use, disappearance and re-emergence of concrete as a building material must be analyzed.

CONCRETE: THE BEGINNINGS

Concrete, rooted in Antiquity, has always been a building material known for its strength and durability. Over the course of its long life, it matured in composition, design and even form to become the architectural medium iconographic of the Modern Movement. However, its use, development and refinement in America did not effectively take root until the nineteenth century. Thanks chiefly to the workings of structural engineers and architects in France and Britain, the nineteenth century saw the launch of concrete's "change in design

from intuition to calculation, and in construction from craft to industry,”²⁹ which firmly established it as a building material. When the Industrial Revolution gave rise to the age of the machine and mass production, ideas of expression also advanced – for the architect was able to create unique design of both form and scale that were once incapable by hand. Known for its strength, however, concrete was primarily used as the skeletal component of the structure – hidden behind or in imitation of more “elegant,” traditional materials. As Leopold Arnaud states in “Concrete in Architectural Service,” “nineteenth century eclecticism was an expression of assumed assurance, based upon an academic or archeological familiarity with the expressions of the past, disguising actual bewilderment caused by the appearance of strange new forms consequent to the development of technology.”³⁰

The use of concrete in America over the course of the nineteenth and twentieth centuries developed in distinct stages: first, concrete’s general acceptance as an architectural material, then resolving its technical issues and finally, developing its aesthetic quality. When innovative designers began developing ways to produce concrete, use of the material had to conform to earlier architectural styles in hopes of winning over traditionalists’ affections. Those who sought to express concrete’s artistic qualities developed it as “artificial stone,” allowing others to see the advantages of concrete’s moldability. This led to its acceptance as an architectural building component. Yet, before further artistic refinement could be reached, manufacturers had technical issues with which to grapple and refine: structural

²⁹ R. J. M. Sutherland, “Pioneer British Contributions to Structural Iron and Concrete” in *Building Early America*. (Radnor, Pennsylvania: The Carpenters’ Company of the City and County of Philadelphia/Chilton Book Company, 1976), 96.

³⁰ Leopold Arnaud, “Concrete in Architectural Service.” *Journal of American Concrete Institute* 35. (April 1939), 356.

stability, durability, reinforcement, etc. Emphasis was placed on understanding the material's structural properties. Lastly, only when the medium was capable of optimal building performance could architects actually begin to use its full, moldable – artistic – potential.

The nineteenth century building industry focused on the development of concrete as an acceptable architectural material and the refining of its structural properties for optimal building performance. Beginning with the manufacturing of natural and artificial cement, this chapter seeks to identify the development of concrete during the nineteenth century – setting the stage for John J. Earley's work in the 1900s. Recognizing the knowledge and scientific understanding of concrete both in America and overseas by the beginning of the First World War will then place Earley's work within the context of technological development of the material. Earley's development of a new aesthetic concrete based upon both craftsmanship and industrial quality and durability will be highlighted against the first applications of the material, emphasizing the revolutionary shifts in the architectural expression of concrete made by Earley in the twentieth century.

MANUFACTURING CEMENT GLOBALLY

The revolutionary development of concrete would not have been possible without the advancements made in the manufacturing of cement in the eighteenth and nineteenth centuries. Cement, one of the three most important ingredients of concrete (together with aggregates and water), provides the fluid-like “glue” responsible for the material's cohesion. The rethinking of concrete as an artistic material was only possible once it was determined that this ingredient could be produced globally.

Although the earliest recorded production of cement dates back to the Roman's first century creation of a hydraulic lime cement, the use of concrete was practically discontinued until the eighteenth and early nineteenth centuries – that is, until certain events led to the systematic means of manufacturing cement.

In 1756, John Smeaton produced a hydraulic cement to rebuild the third Eddystone lighthouse; this event was the catalyst for the rapid evolution of concrete in both Europe and America for the following centuries. Through his studies, Smeaton determined that the setting of mortar under water was dependent on the presence and extent of impurities of siliceous particles in the limestone - not on the hardness of the stone from which the lime came, which most cement producers at the time believed.³¹ This discovery led to James Parker's patent for producing hydraulic cement by burning lumps of chalky clay, grinding the product and using it in place of lime; thus, these two men led the growth of the natural cement industry. America saw early on the advantage of such productions; in 1818 Canvass White found the geological formations of New York - abundant in natural cement rock and limestone - suitable for producing natural cement which he used in constructing the Erie Canal.³²

While the natural cement industry stimulated the rapid use of concrete, the development and growth of the artificial cement industry truly led to the large-scale manufacturing and use of concrete in the late nineteenth century. In 1824, Joseph Aspdin developed artificial cement he called "Portland cement" due to its likeness to English

³¹ Fred W. Haglock. *A Treatise on the Manufacture of Artificial Stone and Concrete for Building and Ornamental Purposes*. (Cleveland: Art-Stone Pub Co., 1904), 15.

³² Jo Ellen Freese, "Ornamental Precast Concrete." (Columbia University, Department of Historic Preservation Thesis, 1983), 5.

Portland stone. American use of Portland cement increased as the reputation of Portland cement grew; product importation sparked immediately following the Civil War since reconstruction projects called for more pretentious buildings with bigger concrete foundations.³³ It was in 1828, however, that Professor Fuchs of Munich truly revolutionized the field; his studies demonstrated that Portland cement could be produced anywhere from a variety of materials.³⁴ Once quarrying factories and developers heard of such findings, cement manufacturing industries sprang up everywhere. Of particular importance was the development of America's first artificial cement factory; in 1871, David O. Saylor patented a domestic equivalent of English Portland cement and used his natural cement plant in Coplay, PA, to manufacture the product. This local manufacturer, combined with Portland cement's reputation of performing remarkably well in extreme weather, led American engineers to specify the use of Portland cement for a majority of civil and military works. America was beginning to exploit concrete's capabilities; however, it was not until the development of precast concrete in Britain and aesthetic concrete finishes in France that America could see concrete's full potential as an architectural medium.

BRITAIN'S CONTRIBUTIONS TO PRECAST CONCRETE

The year 1875 is typically regarded as the birth date of precast architectural concrete. Prior to this date, concrete was mixed in-situ and poured into wooden formwork. It should be noted here that at this time, "a building of any size required considerable dismantling and reassembly of formwork which had to be located each time with extreme accuracy."³⁵ This

³³ Ibid, 10.

³⁴ Charles A. Miller, Jr. "Concrete Construction." *Architects and Builders Magazine* 6. (October 1904), 2.

³⁵ A. E. J. Morris, *Precast Concrete in Architecture*, (New York: Whitney Library of Design, 1978), 5.

early in-situ concrete required highly skilled laborers to ensure both proper formwork and an even placement of the concrete itself. Contractors wondered how the construction process could be altered to use cheaper laborers than the skilled craftsmen required. As a result, the development of precasting techniques stemmed from a desire for economies for concrete in both formwork and labor.

With William Henry Lascelles' patent for "Improvements in the Construction of Buildings" in 1875, the age of precast concrete cladding and prefabrication – key characteristics in Earley's work – began. Lascelle's system called for "precast concrete panels [to be] fixed back to a previously erected structural frame."³⁶ The slabs "are cast in moulds, the faces of which are prepared with any suitable prints to produce an ornamental surface on the slabs."³⁷ This was the first technique that differentiated concrete paneling from the structural skeleton of the building – a differentiation that created a new use for concrete in the form of decorative architectural cladding.

Despite this great stride in the development of concrete cladding, the debate for the material's place as an architectural medium would still remain in dispute until the twentieth century. The initial expression of precast concrete was for pure imitation; concrete was an economical solution to achieve the same desired aesthetics of traditional materials, namely stone. The earliest precast concrete blocks imitated natural stone, both in appearance and dimension. Advertisements labeled the product "artificial stone," highlighting the material's ability to mimic its costly quarried and shaped predecessor. Precast facing slabs, as

³⁶ Ibid, 10.

³⁷ Freese, 7.

developed by Lascelles, mimicked earlier stone veneer, where slabs of stone were fixed to a separate backing wall. Though these techniques are the beginnings of later precast concrete cladding, the material's economical cost and durability, in terms of resistance to water penetration and effects of frost, superseded the aesthetic expression of concrete during the nineteenth century, for the material was generally regarded as "incapable of artistic treatment."³⁸

CONCRETE AS A SCULPTURAL MATERIAL IN FRANCE

While Britain was making strides in the precasting industry, France took the lead in analyzing the sculptural possibilities of this plastic medium. George Godwin's 1835 "Prize Essay Upon the Nature and Properties of Concrete" describes the early use of a material named "beton" (concrete) in France.³⁹ As early as 1832 Francois-Martin Lebrun designed and built houses entirely fabricated of concrete.

Concrete of a superior quality was the result of the working of Francois Coignet in Paris in the second half of the nineteenth century. Coignet patented a stone known as "Beton Agglomeré," a structural concrete used for monolithic construction and ornamental work in 1859. Coignet identified a critical component in concrete production at this point in its development as a building material: the amount of water added to dry cement was indicative of specific performance characteristics, namely, durability and plasticity; thus, the beginnings of optimizing the water-cement ratio – critical to concrete production – were

³⁸ Ibid, 8.

³⁹ George Godwin, "Prize Essay Upon the Nature and Properties of Concrete," *Transactions of the Royal Institute of British Architect* 1, (1835), 10.

established. Instead of adding water to the point that a mortar-like consistency is produced (as was customary), Coignet only added a small quantity of water to produce a firm plastic paste. By 1860, Coignet's factory in St. Denis introduced a consistently controlled, mixing technique for un-reinforced in-situ concrete with a low water content and improved performance.

Coignet's work exposed the material's potential on a national level; his buildings gained increasing recognition. However, as Coignet's work was analyzed on the national scale, inherent problems began to surface. It was at this point in concrete's history that scientists began working with Coignet's newly determined "water-cement ratio" to understand how this property would affect the concrete's performance. The later part of the nineteenth century was the beginning of scientific analysis and empirical testing of concrete's characteristics, such as water permeability, expansion and contraction, and adhesion characteristics.

Coignet believed in his material, and the constant study of its aesthetic possibilities "substantiated his belief in unfinished concrete as a suitable exterior for structures."⁴⁰ According to Coignet, "the reign of stone in building construction seems to have come to an end. Cement, concrete and iron are destined to replace it. Stone will only be used for monuments."⁴¹ Gaining support for his belief in concrete on the national level, however, was difficult. The wide-scale use of concrete still followed closely to those developments in Britain, "whereby fashionable architects sought to emulate for their less wealthy clients the

⁴⁰ Ibid, 34.

⁴¹ Ibid, 34.

splendor of earlier reigns.”⁴² Concrete in France imitated stone, brick and other more expensive materials for the developing middle class that could not afford the expensive, traditional media. However, “lime-based stucco rendering of rubble masonry or brick walls was much more widely used in France as a traditional finish and the expertise gained in repetitive casting on complex moldings against timber formwork undoubtedly facilitated subsequent French acceptance of comparable concrete requirements.”⁴³ France was moving toward an aesthetic concrete.

In the last quarter of the nineteenth century, Francois Hennebique’s work with precast concrete shows the French shift to the architectural expression of concrete cladding. Hennebique’s initial use of concrete was as the building’s structural skeleton hidden behind a sand rendering, seen on the exterior of his Paris office building in 1898. However, he soon began experimenting with exposed concrete cladding. In 1904 he completed the Bourge-la-Reine house, a structure composed of monolithic in-situ concrete walls faced with applied precast concrete slabs applied. These exterior slabs were then tooled to expose the flint aggregate, making it one of the earliest instances of exposed aggregate precast slabs in an attempt to aesthetically express concrete.

Hennebique’s idea of exposing the exterior of concrete slabs was not a revolutionary idea. In America (which will be discussed in the following section), Ransome was experimenting with similar processes on some buildings at Stanford University at the same time that Hennebique was developing Bourge-la-Reine. In France, August Perret’s

⁴² Collins, 19.

⁴³ Morris, 33.

reluctance to face the exterior concrete with ceramic tiles at 25 bis rue Franklin in 1909 was another stride for precast concrete; he reasoned that “the tile pieces could take the place of the aggregate to produce rich concrete on top of poor concrete.”⁴⁴ Prior to this idea of substituting traditional aggregate with more aesthetic materials, such as ceramics and glass, Perret produced the first use of precast concrete cladding in its modern form. His 1904 church of Notre-Dame du Raincy consisted of an “evolved fenestration system of thin precast concrete wall panels that could be economically mass-produced on site, to his own dimensions, and which would still be light enough to be readily manhandled into position. Window and door openings within frame bays were formed by incorporating storey-height precast frames.”⁴⁵ An underlying principle of precasting developed from this construction: that of the relationship between in-situ and precast concrete. Perret believed the two could coexist to create a harmonious structure; the in-situ concrete provided the permanent, structural skeleton of the building while the precast panels created the decorative enclosing and partitioning vocabulary that would be visible to the world. This harmonious collaboration of structural concrete and precast, decorative concrete panels would be refined in the twentieth century American works of John J. Earley.

TOWARD AN AMERICAN AESTHETIC

The development of precast architectural concrete in America stemmed from the previous three stimuli: the wide-scale manufacturing of cement, the developments in British precasting, and the progress in French concrete aesthetics. At the same time, there were events and ideas stirring in America which allowed the country to take the lead in developing

⁴⁴ Collins, 20.

⁴⁵ Ibid.

a refined aesthetic finish for precast concrete slabs. In fact, it was understood that by the twentieth century “a mature understanding of practically all current surface finishes had been reached in the USA” for exposing concrete.⁴⁶

The American interest in concrete construction was “fueled largely by the primary American desire to find ways of doing things that were cheap, quick and easy. Its story is characteristic of the immediate, imaginative American recognition of unprecedented technical possibilities and the willingness to do what had never been done before, with the tastelessness of a new middle class society that accepted substitute grimcrackery for traditional materials and ideals.”⁴⁷ The technological revolution of the nineteenth century led to machine-led production, enabling architects and engineers to develop innovative styles, especially with the moldability of concrete. However, concrete was used primarily for sidewalks, foundations, brickwork, heavy masonry construction and large-scale projects such as White’s Erie Canal in 1818. The principal concern for those who advocated its use was that of economy. Those who looked for alternate ways of using concrete were “limited to experiments with waste material and the use of the unskilled laborer”⁴⁸ leading to many failures. These setbacks deterred many people from pursuing concrete as an alternative to natural stone. Furthermore, the unsightly appearance resulting from the unskilled hand and murky color of the grey cementing material led to the presumption that concrete work must be faced with stucco, with ornamental plaster or must imitate stone in order to be seen as a work of art.

⁴⁶ Collins, 90.

⁴⁷ Ibid.

⁴⁸ Ibid, 53.

Concrete's capabilities of withstanding compression loads were, at this point, well known; so too was its weak performance under tensile stresses. To rectify this, it was determined that if metal, which performed well in tension, was embedded in the concrete, the concrete and metal would adequately carry the combination of structural loads, providing a balanced building system. Thus, the growth of the steel industry led to the development of reinforced concrete in America.

The development of reinforced concrete marked a significant boom in American concrete architecture of the 1870s – as well as the rudimentary beginnings of a scientific understanding of the material. Concrete provided a perfect fireproofing for a structural frame;⁴⁹ as a result, multiple cast stone (as artificial stone was also called) companies sprang up in the 1860s and 1870s. Ransome's Concrete Stone of 1861 and George A. Frear's patented "Artificial Stone, Mastic, Cement, etc. and Pressing Machine" in the 1880s became the chief imitation stone in the late nineteenth century. These companies advertised that their products' "cost is less than half that of natural stone in details of an ornamental character, especially where there is much repetition, and its enduring quality is now so fully established as to need no comment."⁵⁰

American precast companies developed further from a desire to provide cheap and timely housing developments across the country at the turn of the century. Led by Ransome, the Pacific Stone Company in San Francisco provided pre-fabricated houses. Even Thomas Edison boasted precast concrete's ability to "provide cozy houses for working

⁴⁹ Collins, 56.

⁵⁰ F. Ransome, "On Some Recent Improvements" in the *Manufacture of Artificial Stone*, (Philadelphia: Merrihew and Son, Printers, 1873), .5.

men at a cost one-sixth to one-fourth of what the average mechanic pays today.”⁵¹ This, coupled with the introduction of the rotary kiln, a machine which produced cement fixed speeds and temperatures, led to a belief in the mass production potential of “incremental assembly line manufacture of economically priced products based on a range of standardized, inter-changeable components,”⁵² a system that would become indicative of the twentieth century American industry.

As machines simplified labor-intensive techniques, designers were beginning to see concrete’s potential for aesthetic decoration. “Honesty of expression” became the catchphrase at the turn of the century, and America had a handful of architects ready to experiment with the material in drastic forms of expression. Ransome’s use of bush-hammering techniques at Stanford University exposed the aggregate finish of concrete. Although the work opened other architects’ eyes to treating concrete as a decorative finish, it had little impact on the precasting industry in the long run. It was Frank Lloyd Wright’s Unity Temple that was the first American building in the limelight for its use of exposed concrete in 1906. The church’s cast-in-place concrete exterior was wire-brushed at a particular moment during the curing period to reveal the pea gravel aggregate in the mix. Highlighted as “the first building to be let alone as architecture after the forms were removed,”⁵³ it revealed the material’s aesthetic potential by removing the surface skin of cement laitance to reveal the aggregate so as to “rescue so honest a material from

⁵¹ Freese, 85.

⁵² Freese, 87.

⁵³ Frank Lloyd Wright, “The Meaning of Materials-Concrete,” *Architectural Record* 64, (1928), 102.

degradation.”⁵⁴ Architect A. O. Elzner saw the twentieth century as a time for concrete’s change.

It is not incumbent upon us to face the concrete with marble, or brick, or terra cotta ... the architectural forms, moldings and whatnot, will be incorporated with the moulds for the structural work, and upon removing the formwork, the surface of the exposed concrete will be given the desired finish of rubbing or tooling as the case may be. Thus we will have a truly rational architecture, in which there is no sham, no deception, a solid thing, no joints, every member incorporated with and a part of a living body.⁵⁵

Techniques for aesthetically enhancing the appearance of concrete also incorporated the first uses of decorative concrete panels during the early quarter of the twentieth century. Frederick Taylor’s *Concrete, Plain and Reinforced* of 1905 states that “exposed concrete walls should not be plastered. It is a needless expense and the results in variable climates are unsatisfactory” and continues to describe methods of exposing the aggregate of concrete by bush hammering and water washing.⁵⁶ W.M. Walter Smith’s *The Ornamental Treatment of Concrete Surfaces* describes acid-etching and sand-blasting, as well as introduces the possibility of colored surfaces by way of artificial pigments and colored, special aggregates.⁵⁷

The most popular way to alter the murky grey tone of concrete at the time was to add various mineral pigments; however, these had a strong tendency to fade with time and particular dyes seriously weakened concrete’s cohesiveness – as the chemicals in pigments would alter the chemical makeup of the cement and, therefore, alter the cohesive bonds

⁵⁴ Ibid.

⁵⁵ A.O.Elzner, “The First Concrete Skyscraper.” *Architectural Record* 15. (1904), 531.

⁵⁶ Frederick Taylor, *Concrete, Plain and Reinforced*, (New York: John Wiley & sons, 1905).

⁵⁷ W.M. Walter Smith, “The Ornamental Treatment of Concrete Surfaces,” *American Architect* 101, (1912): 33 – 42.

between aggregate particles. As a result, artificial pigments were developed to resist fading and were mixed at the factory to obtain more reliable results; concrete companies offered many different colors and shades in early years of the century.⁵⁸ Still, pigments fell short of the designer's aesthetic intentions.

Seeking alternate solutions, manufacturers began to emphasize that the selection of aggregate was the key to not only creating a desired color but also a desired texture.⁵⁹ They stressed that choosing aggregates was the “only truly correct and practicable manner of obtaining strong and durable colors without sacrificing the strength of the block. There are but few plants in which this method has been extensively used, but it is the method which must survive.”⁶⁰ Silica sands of various colors were marketed in bags and various aggregates were used for duplicating specific stone. Ransome's company boasted that “even marbles and other finer varieties of stone of different tints and capable of a high polish could be produced by using mineral pigments for the coloring and crushed quartz or other broken stone for part of the aggregate.”⁶¹ Although its ability to mimic natural stone was still concrete's most desired asset, it is here that companies began to experiment with producing aesthetic qualities in the mix, such as varying colors and aggregates to produce a desired finish. Since the ability to create a specific texture on concrete facing required a concrete that was cured, durable and hard, tooling, rubbing and hammering were taken directly from the stone cutters' trade; this kept these processes within the hands of the craftsman. The techniques were refined with time as manufacturers learned through practice. At the turn of

⁵⁸ Freese, 49.

⁵⁹ Ibid, 46.

⁶⁰ Harmon Howard Rice, *Concrete Block Manufacture*, (John Wiley and Sons: New York, 1906), 53.

⁶¹ Ibid, 15.

the century, retarders were developed to prevent the cementitious film from setting and thus, expose the concrete without treating the surface. Wire brushes eliminated the plastic effect of the cast cement by scrubbing the surface. Acid washing brought out the aggregate, brightened the surface and didn't have to be used immediately on newly-placed concrete.

Architects' desire to use this "machine aesthetic" was still far from complete at the beginning of the twentieth century. Although "a mature understanding of practically all current surface finishes had been reached in the USA,"⁶² surface finishes were discussed mostly for cast-in-place concrete until the 1920s and 1930s. The emphasis on in-situ and cast-in-place concrete was chiefly to allow unskilled laborers to pour the concrete and then hire skilled workers to create the aesthetic appearance, separating the production of concrete from its aesthetics

STANDARDIZATION AND TESTING

As stated earlier, the arc of development of a material or process is first experimental, then proprietary through patenting and copyrighting, and finally standardized and globalized in the formation of industry-wide organizations. Large-scale uses of concrete were advanced within government institutions; the Federal Bureau of Standards developed basic building codes and concrete design guidelines by the end of the nineteenth century. The Army Corps of Engineers' promulgated the use of unreinforced and reinforced concrete construction in the construction of national dams and fortifications. In terms of architectural concrete, architects and engineers formed organizations whose aims were to conduct research and testing on nascent materials, develop industry standards for

⁶² Collins, 90.

widespread use, and publish the most recent information, research and analysis for all developers. With the development of the American Concrete Institute in 1905, an organization was now instated that dealt with the general problems of concrete construction: strength, material proportioning, formwork, general construction techniques, etc. Not only was this organization in charge of publishing production and construction information for manufacturers, but the group founded committees to test the products, offering recommendations based on experimental results and simultaneously stimulating the rapid spread of concrete construction.

This fast-paced revolution stimulated the beginnings of two key themes that would be vital characteristics of the twentieth century American building industry: that of empirical scientific material testing and of production standardization on behalf of cement and concrete producers. As the technology of producing cement and concrete developed, manufacturers learned from their earlier mistakes, refining their techniques. Many of the early structural and aesthetic issues with the material were resolved with every advancement – and setback.

The earliest recorded scientific study of concrete came in 1871 from Gillmore. In his work, *Coignet-Beton and Other Artificial Stone*, the scientist examined concrete samples from Coignet, Ransome, Frear, the American Building Block, Sorel Artificial Stone and Portland Stone to determine their comparative tensile and compressive strengths, their percentage water absorption and their deterioration resulting from freezing. Although the results of this experiment are unreliable due to inconsistent testing, it does give insight into the beginnings of experimental material testing and identified key performance characteristics that would be

studied for the years to come. From these studies, standards would be established to produce optimal material performance.

Due to the growing demand of concrete and the rapid development of mass production systems, the need for performance criteria became more apparent. Designers and manufacturers quickly understood that “construction without prescribed engineering standards resulted in many accidents and failures. Surfaces, through carelessness or lack of properly developed processes, were subject to rapid deterioration.”⁶³ Some of these alarming failures in concrete construction awakened manufacturers to the importance of the quality of their materials. In the beginning decades of the twentieth century, the United States government specified minimum requirements for tensile and compressive strength based on days cured and the 1, 7, and 28-day curing intervals continue to be the basis for an essential quality test for concrete today. Freezing and firing tests were also conducted to determine the material’s ability in varying temperatures and conditions. Manufacturers began supplying performance data sheets with their products. Building codes were finally established; in 1917, the American Concrete Institute adopted Standard No. 10 for the production and use of architectural concrete with a minimum compressive strength of 1500 psi at 28 days and less than 10% absorption when thoroughly dried and immersed in water for 48 hours.⁶⁴ Criteria for individual components of the concrete mix, such as aggregate selection and gradation, as well as component proportions, were deemed critical in performance during the beginning of the twentieth century – especially since many failures were previously due to incomplete hydration/mixing of the concrete. Since Coignet, the

⁶³ Ada Huxtable, “Historical Survey: Concrete Technology in the US,” *Progressive Architecture*, (October 1960): 144.

⁶⁴ Whipple, Harvey. *Concrete Stone Manufacture*. (Detroit: Concrete-Cement Age Publishing Co., 1915), 296 – 299.

development of the definite water-cement ratio was established to produce maximum strength; any deviation from such quantity was accompanied by a considerable decrease in strength.⁶⁵ Specifications identified that curing must take place within a moist environment with the poured material covered by damp burlap or carpet.

As the century continued, several organizations continued to refine concrete construction. Representatives from the American Society of Civil Engineers, American Society for Testing Materials, Portland Cement Association, American Concrete Institute, American Railway Engineering Association, and the American Institute of Architects held periodic conferences aimed at developing and promoting the most adequate advancements in the development of reinforced concrete.⁶⁶ Thought primarily focused on the durability and performance of reinforced concrete, hardly mentioning the material's aesthetics.

The 1916 report was limited to fundamental principles of design and gave but little attention to details. The 1924 report still placed main emphasis on fundamental principles but because of the considerable advance in the control of the strength of concrete, higher working stresses were recommended and design details, constants and procedures were recommended in greater detail. The 1940 report featured changes in the following items: light weight aggregate, emphasis on concrete durability, the introduction of alternate specifications in proportioning concrete by engineering specifications and production of concrete of specific quality.⁶⁷

As noted, there was a shift between the 1924 and 1940 reports that led the joint committee to consider "concrete of specific quality." What led to the development in thought towards concrete for more than just utilitarian use?

⁶⁵ Childe, 27.

⁶⁶ Jasper O. Draffin, "A Brief History of Lime, Cement, Concrete and Reinforced Concrete," *ACI Special Publication* 48, no. 1, (22 October 1942).

⁶⁷ Ibid.

CONCLUSION

By the first quarter of the twentieth century, reinforced concrete architecture became a global occurrence. It only took a very short period for concrete manufacturing to mature from a craftsman's family-shop business to a highly sophisticated production technique based on scientific principles and testing. Its performance criteria was established and guided by the various building codes and standards developed by such organizations as the Portland Cement Association, the American Concrete Institute, and the Federal Government.⁶⁸ These professional organizations were left the responsible parties charged with disseminating the most current information on scientific studies and promoting the most adequate methods to achieve both a durable and architectural product. In terms of the ever-advancing "architectural concrete" of the early twentieth century, techniques were already in place to produce an aesthetic for exposed concrete structures. However, the procedures were specified for in-situ or cast-in-place concrete, still more advantageous to construction companies because it allowed the use of unskilled, cheap laborers. The development of production standards for precast architectural concrete will not take root until the 1920s, when John J. Earley and the Bureau of Standards begin their work on a new aesthetic for concrete construction.

⁶⁸ Freese, 120.

CHAPTER 4: JOHN J. EARLEY AND THE EARLEY PROCESS

INTRODUCTION

While empirical testing had established concrete as a structural material, the aesthetic possibilities of the material remained under-developed and somewhat crude at best until the 1920s. Innovative thinking was needed to synthesize the pragmatic and performance advances of concrete production and casting, including precasting, with a disciplined approach to experimentation of aesthetic and expressive possibilities for the exposed surfaces. According to historian A. E. J. Morris, these techniques evolved in the 1960s; ⁶⁹ however, Morris's statement misses the key events and persons that birthed the unique material about thirty years earlier. Though post-World War II construction saw the re-emergence of precast exposed aggregate concrete cladding (which will be discussed in the following chapter), it was the work of John J. Earley in the first half of the twentieth century that spawned a refined material similar to reinforced concrete in both components and criteria but truly unique in design and production. Precast aggregate facing techniques, using "a comparatively thin surface layer of expensive, special aggregate concrete and an ordinary backing mix which was revealed by water-washing at the correct curing stage," ⁷⁰ were the results this craftsman's continual efforts.

Concrete worthy of architectural recognition was highlighted in the works of John J. Earley, whose background as a stone carver and beginning work with stuccos at the Bureau of Standards led to his shift in thought to exposing texture and color in precast concrete

⁶⁹ Morris, 92.

⁷⁰ Ibid.

cladding that is seen today. His background and early experiences with stucco gave him a unique perspective on concrete, developing within him a scientist's understanding of the implications and importance of gradation for durability, a craftsman's understanding of traditional surface decoration (such as mosaics) and an artist's understanding how visible light and surface texture, color and reflectance interact.

THE BEGINNINGS (1900S)

A fifth generation descendant of Irish stone carvers, John J. Earley was born in 1881 and immediately exposed to the sculptural work of craftsmen in his father's Washington, DC studio. By the time of his apprenticeship in 1898, the Earley Studio was already a regular Federal contractor – an important relationship that will aid Earley's revolutionary career. Eight years later, at age 25, he and handyman-turned-sculptor, Basil Taylor, took over the Earley Studio after his father's death.⁷¹ The two transformed the Studio from a stone carver's shop to a plaster and stucco studio. (Figure 1) Stucco-finished buildings were experiencing a revival, especially with the proliferation of concrete structures, and this growing response to stucco-finished projects led the Earley Studio to experiment with and continually develop this material until it ceased production in 1973.

The development of John J. Earley's career and how it significantly shaped the precast concrete industry can be explained chronologically, for with each commission Earley learned and developed something new with the unique material he was using. His widening thought on the material and its capabilities resulted in the evolution of precast architectural concrete panels from applied stucco finishes. For thirty years, his constant desire to learn,

⁷¹ Frederick Cron, *The Man Who Made Concrete Beautiful*, (Ft. Collins, CO: Centennial Publications, 1977).

study and experiment led to the ultimate Earley Process of developing precast exposed aggregate concrete cladding which is still used today. He also produced and tested project samples, a shift in the way traditional buildings were developed and a direct correlation to the development of other twentieth century, modern materials. It is indicative of his determination to develop not only an aesthetic worthy of concrete's strength, but a permanent and durable material for Earley stressed how "well-made concrete is as permanent as the most permanent building materials known to the industry [and] that a well built concrete building will outlast its usefulness, and will require very little maintenance."⁷² Understanding that as a craftsman, he had scientific limitations, Earley studied, read and experimented until he was certain he had achieved an adequate product, a product in which "intuitions had been well founded and science subsequently retracing their paths, [the paths of craftsmen], have approved with notable regularity."⁷³ It was this mindset of craftsman, experimenter, innovator and perennial student that allowed Earley his success.

THE BUREAU OF STANDARDS (1910S)

The corrosive action responsible for the failure of early stucco projects placed over metal lath led the Associated Metal Lath Manufacturers to request an investigation of the causes of metal lath corrosion in 1910. The Bureau of Standards of the Commerce Department in Washington, DC, led by the Bureau's cement chemist J. C. Pearson, conducted a cooperative research project in 1911, requesting the aid of the Earley Studio to

⁷² John J. Earley, "Mosaic Ceilings, US Department of Justice Building." *Journal Proceedings of the American Concrete Institute* 31, no. 5, (1 May 1935): 564.

⁷³ John J. Earley, "On the Work of the Committee on Architectural Concrete of the Exposed Aggregate Type and the Thomas Alva Edison Memorial Tower," *Journal Proceedings of the American Concrete Institute* 34, (May 1938): 601.

create test panels.⁷⁴ The project kindled the successful professional relationship between Earley and Pearson; another investigation was conducted in 1914 to understand the properties of stucco and how to minimize the natural occurrence of map-cracking and crazing that occurred once the stucco dried. Again, the Earley Studio was the craftsman shop responsible for the stucco work; the Bureau developed an advisory committee, to which Earley was appointed, to supervise the process. Earley began to experiment with and deviated from the traditional, accepted process of stucco application; instead of using an intense wet application involving the soaking of the undercoat to secure adhesion to the façade, Earley determined that a light dampening of the undercoat produces the same adhesion but with less cracking. Thus, it was determined that water and the method of production were contributing factors to the cracking seen in stucco application. Earley did not stop there; he became infatuated with developing the material further and quickly realized that “adherence to well-established practice, structurally sound and durable stucco could be secured, but that a great deal could be, ought to be, done to improve its appearance.”⁷⁵ Together, Earley and Pearson led developments in stucco finishes that would eventually be adopted to concrete paneling. As Earley notes, although the term “stucco finish”

has been applied to the ordinary toweled or floated surfaces which is given a final scrubbing treatment with a brush and water or a cleaning with an acid wash, the name will be used here in connection with a finish which should be more properly designated as a surface treated concrete. The exposed aggregate finish is obtained by applying a finish coat which in itself is a concrete with miniature aggregate. The cement and fine sand bear a definite relation to the coarse aggregate which predominates the mix. This coating is

⁷⁴ Cron, 20.

⁷⁵ John J. Earley and J. C. Pearson, “New Developments in Surface Treated Concrete and Stucco.” *Journal Proceedings of the American Concrete Institute* 16, no. 2, (1 February 1920): 71.

applied and after it has stiffened the surface film of cement and fine aggregate is removed by gentle brushing with a wire brush and then the coat is left to harden and dry out. Next, it is washed with dilute acid and clean water. By removing the cement and fine particles the color of the surface is determined by the color of the aggregate and its texture by the size and shape of the coarse particles. While this treatment ranks first as a stucco finish, it is also the most difficult of stuccowork to plan and execute. By the use of colored aggregates the most beautiful of color tones can be obtained and due to its density and texture many of the common structural defects can be eliminated. To carry out the work successfully requires the selection, grading and proportioning of the aggregate from knowledge of size effect and color tone, and to obtain a uniformity of appearance over the entire surface requires the highest type of workmanship in the application and finishing of the coat.⁷⁶

Earley immediately recognized the correlation between stucco and concrete – a connection that led to his development of precast concrete panels in the coming decades.

FROM DECORATIVE STUCCO TO ARCHITECTURAL CONCRETE (1920 – 1940)

The Earley Studio's relationship with the Federal government – and Earley's burgeoning relationship with Pearson – led to Earley's first well-known commission: Meridian Hill Park. It is here where the quick-paced development of exposed aggregate concrete is launched. The Office of Public Buildings and Grounds decided to landscape a city park on the outskirts of the capital; since "congress refused to appropriate sufficient money for stone,"⁷⁷ the park was to be composed of concrete. Earley was asked to do the final stucco coating to all concrete elements. Before implementation, however, an Earley test sample must first be approved by the chairman of the U.S. Fine Arts Commission, distinguished architect, Cass Gilbert. The first concrete stucco samples "did not give the

⁷⁶ J. C. Pearson, *Bureau of Standards Research on Stucco Finishes*, (1920): 31 – 32.

⁷⁷ James W. Mann, "A pioneer in the use of exposed aggregate concrete," *Concrete International*, (October 1979): 84.

appearance of strength and size equal to its task as a retaining wall. The color was unsatisfactory.”⁷⁸ To ameliorate this distaste, Earley decided to adjust the casting process by casting the concrete elements against plaster molds to produce deep rustications and, thus, create areas of shadow and highlights in the molded forms. During this phase, Gilbert recommended a finish resembling the pebble mosaics in Italy and suggested pressing the pebbles into the mortar while still in its plaster stage. Worried about the durability of poorly engaged pebbles during Washington’s winters, Earley suggested adding the pebbles during the mixing of the concrete and incorporating them into the mix design. He hypothesized that, by stripping forms from the concrete while still “green” (not fully set), he would be able to expose the larger pebbles by removing the surface layer of sand and cement with wire brushes, leaving the pebbles in relief. Although the effect of stripping the formwork from the concrete while still green and exposing the partially cured concrete surfaces with a dilute acid was already known,⁷⁹ Earley envisioned a new aesthetic opportunity for concrete, where “this method of treating the surfaces at once supplied the sense of strength and size that was lacking before. [it was] reinforced concrete, and nothing else.”⁸⁰ Earley coined this new material “architectural concrete,” where “concrete be thought of as an aggregate, which is held in place by the least possible amount of hardened cement paste, and which before the hardening of the cement was flowed into place in a vehicle of water.”⁸¹

⁷⁸ John J. Earley, “Some Problems in Devising a New Finish for Concrete.” *Journal Proceedings of the American Concrete Institute* 14, no. 6, (1 June 1918): 127.

⁷⁹ J. H. Chubb, “Artistic and Commercially Practical Surface Finishes for Concrete Work” *Engineering Record*. (3 April 1907): 415.

⁸⁰ John J. Earley, “Some Problems in Devising a New Finish for Concrete,” 128.

⁸¹ John J. Earley, “Architectural Concrete” *Journal Proceedings of the American Concrete Institute* 20. (1924): 157.

Meridian Hill (Figures 2 and 3) was an experimental project in which Earley advanced his new applications of a staid material with each stage of production. Earley produced an artistic surface treated concrete; however, the first trial to expose the aggregate in the concrete elements at Meridian Hill Park revealed two problems: one of appearance and the other of production.

Appearance (Color and Texture)

Earley's first attempts at a concrete of architectural distinction followed generally accepted ingredients and production. Earley wrote,

The concrete mix was the standard 1:2:4. The cement was a standard brand passing the tests of the Bureau of Standards. After 24 or 48 hours, according to the condition of the cast, the forms were removed and the surfaces scrubbed with a steel brush until the aggregate was exposed as evenly as possible. The entire unit was then thoroughly washed with water from a hose. The seasoning was carefully watched and frequent wettings were used to prevent too rapid drying.⁸²

After exposing the aggregate by this process, it was seen that the pebbles tended to bunch together, creating a non-uniform appearance. Earley and Pearson, members of the newly-formed "Committee on the Treatment of Concrete Surfaces" in the Bureau of Standards' Stucco Investigation, were resolved to solve this problem. Earley, after reading all available current specifications for structural concrete, came to the conclusion that the problem of surface uniformity was in the proportioning of concrete's ingredients. He determined that "if the aggregate is to be the source of color, the concrete must be designed

⁸² Ibid: 130.

and manipulated as to deposit in the surface the greatest possible amount of aggregate.”⁸³

Thus, in order for the aggregate to be the color exposed within the concrete mix,

the arbitrary 1:2:4 mix had to be abandoned and another formula evolved which would deposit the particles of aggregate in the mold as closely to one another as possible. The frequency with which the spots appeared on the surface was principally influenced by the composition and the consistency of the concrete, by the care in which it was placed; by the uniformity with which it was mixed; both as regards the proportioning of the ingredients and the length of time it was allowed to remain in the mixer.⁸⁴

The Earley Studio experimented with many different variations of aggregate, sand, cement and water and concluded that in order to produce the desired aesthetic, a step-graded or gap-graded approach to aggregate sizing was necessary. In this system, two sizes or gradations of aggregate would be chosen: the larger representing the latter color that would come through the concrete elements and the smaller aggregate that would fit in the voids between the larger aggregates. Therefore, once the concrete surface film was stripped, the larger aggregates – being in greatest proximity to one another – will dominate the surface, creating a uniform appearance.

Earley’s two-step gradation secured not only a uniform appearance, but a permanent color and texture that was built directly into the concrete’s ingredients. Previously, pigments and dyes were used to color the cement paste between the pieces of aggregate, but this method weakened the concrete and usually produced an undesirable hue. Earley discourages this technique frequently in his writing.

⁸³ John J. Earley and J. C. Pearson, “New Developments in Surface Treated Concrete and Stucco.” *Journal Proceedings of the American Concrete Institute* 16, no. 2, (1 February 1920): 76.

⁸⁴ John J. Earley, “Some Problems in Devising a New Finish for Concrete,” 134.

The coloring of cement by methods similar to those employed for pigments has not been successful because cement, even white cement, is not a neutral base. It has color sufficient to interfere with that of an added pigment. The difficulty is aggravated by the chemical activity of the cement which attacks the structures of many of our most desirable pigments. Furthermore, the addition of finely ground pigment exceeding a small percent of the volume of the cement is not permitted and as a result concrete cannot be given a hue of great strength.⁸⁵

Although Earley was not the first to develop the gap-grading approach (Professor R. H. McNeilly had developed this system in 1915),⁸⁶ his use of the technique stemmed from his desire to produce a uniform aesthetic; McNeilly, like other scientists at the time, sought durability and strength. Thus, Earley's two-step gradation not only secured a uniform color and textured surface of the exposed concrete, "it gave to concrete the best structural qualities and characteristics of appearance adaptable to our theme and quite different from the appearance of concrete made with aggregate graded by other methods... [it also] gave to concrete better workability...prevented segregation and bridging and gave better flow."⁸⁷ This gradation achieved both aesthetic and structural sophistication, a marriage Earley developed even further with his adjustments in molds and the control of water in his concrete mix.

Production (Molds and the Control of Water in the Concrete Mix)

The second problem that occurred at Meridian Hill was with the interaction between the molds and the "wet" concrete casting. It was seen that a suction or vacuum developed

⁸⁵ John J. Earley, "Architectural Concrete," *Journal Proceedings of the American Concrete Institute* 22, no. 2, (1 February 1926): 165.

⁸⁶ Cron, 20.

⁸⁷ John J. Earley, "Architectural Concrete of the Exposed Aggregate Type," *Journal Proceedings of the American Concrete Institute* 30, no. 3, (1 March 1934): 252.

between the impervious surface of the mold/form and the wet smooth surface of the concrete cast; this created a suction force that was greater than the tensile strength of the concrete, still in its plastic/green state. As a result, pieces of fresh concrete would cling to the form and detach from the mass when the form was removed.⁸⁸

As the Meridian Hill project was underway, J. C. Pearson and Earley were still continuing their experiments with the proportioning of ingredients in stucco. By 1919, they determined that the amount of water in the mortar mix after chemically setting the cement had an effect on shrinkage, which was the primary catalyst for map-cracking and crazing seen on their earlier stuccoed facades. Bureau reports also showed that the most successful stuccos were created when water in the mortar was drawn into a porous base after the finish coats were laid, creating high early strength and rapid curing. Earley reported,

Many samples were made employing different sized of aggregate, different size of sand, and different proportions of the ingredients, especially water. Let me impress the fact that, of all ingredients that enter into concrete, none require more exact care in proportioning than the water. Too much or too little water affects the color and the texture through its effect on the arrangement of the pebbles and the ease with which the casts are surfaced.⁸⁹

Earley and Pearson determined that if the amount of water within the mix could be controlled, they might be able to minimize cracking in stucco applications as well as improve the suction effect within the molds, ensuring permanent and uniform color and texture in the exposed concrete. Once again, the initial samples for Meridian Hill followed accepted techniques in terms of molds and formwork.

⁸⁸ Lori Aument, ““Construction History in Architectural Conservation: The Exposed Aggregate, Reinforced Concrete of Meridian Hill.” *Journal of the American Institute for Conservation* 2, no.1, (Spring 2003): 12.

⁸⁹ John J. Earley, “Some Problems in Devising a New Finish for Concrete,” 135.

The forms were plaster, shellacked on the inside to make them waterproof, and so made that they would fit inside rough wooden forms which were depended upon to support the concrete. [They] followed general practice. The ends were coated with five ply felt and tar to form an expansion joint.⁹⁰

Earley argued that if, after the molds were filled, he were able to remove the unneeded water by means of an absorptive material lining in the molds, he could create a stronger concrete capable of overcoming the problematic suction effect. Pearson recommended removing the shellacking process for waterproofing and “lining the molds with metal foil, or oiled cloth, not only to waterproof them but also to protect the soft plaster surface from damage during casting.”⁹¹ It was soon seen that “these linings were so effective that the studio was able to cast all the capitals with one set of molds.”⁹² This revelation not only solved the suction issue that was destroying 80% of the detail castings, but by using this lining, the molds could be used several times to ensure repeatability in design and detail. Furthermore, this absorptive lining allowed the concrete to achieve high early strength to overcome suction, giving the material a durability now built into its production. Thus, “through his experiments with step grading and exposed colored aggregates, Earley had intentionally secured control over the color and texture of concrete surfaces. Unintentionally, Earley had vastly improved the durability of concrete by withdrawing surplus mixing water before the concrete hardened, a phenomenon

⁹⁰ John J. Earley, “Some Problems in Devising a New Finish for Concrete,” 128.

⁹¹ Robert E. Wilde, “75 Years of Progress: The ACI Saga,” *Concrete International* 1, no. 10, (October 1979): 15.

⁹² Ibid: 15.

demonstrated experimentally by the pioneer concrete scientist, Duff Abrams, in 1918 when he proposed his water/cement ratio law, but which was still not widely known.”⁹³

These discoveries (step-gradation, controlling the water-cement ratio, and the development of absorptive molds through the use of a metal liner) led Earley and Pearson to patent their production of exposed aggregate stuccos and concrete.⁹⁴ The technique to produce a predetermined color and texture in stucco and concrete involved the following procedure:

Upon hardening it will be found that a greater concentration of small aggregate and cementing material will appear at the surface of the mold or the exterior of the stucco work. The larger aggregate will be found to lie in substantially a plane surface about 1/16” beneath the surface and may be exposed by brushing away the surface with a wire brush. If desired the exposed surface of large aggregate may be treated with a weak acid to better bring out the natural color of the same.⁹⁵

Thus, by 1921, Earley had secured the rights to a concrete of step-graded aggregate chosen both for its durability and color, applied to a gypsum mold lined with metal foil or paper fabric - ensuring a low moisture absorption product of high early strength and low initial water content. The panels would then be wire brushed and acid washed to produce an architectural finish of improved color, texture and form. Earley believed in the craftsmanship quality of his material, warning that a material of such superb quality would only come to fruition through “careful supervision and fine workmanship based upon

⁹³ Ibid: 20.

⁹⁴ John J. Earley, *Methods of Producing a Predetermined Color Effect in Concrete and Stucco*. Patent 1,376,748. (3 May 1921); Earley, John J. *Flexible Joints for Stuccoed Buildings*. Patent 1,355,756. (12 October 1920); Earley, John J. *Molds*. Patent 1,412,392. (11 April 1922).

⁹⁵ John J. Earley, *Methods of Producing a Predetermined Color Effect in Concrete and Stucco*. Patent 1,376,748. (3 May 1921).

experience with materials having the characteristics of this step gradation.”⁹⁶ The work of a craftsman was a dominant component of Earley’s process – a distinction between Earley’s stucco and concrete and earlier machine-produced block concrete projects.

Although not of precast concrete, Earley’s production of “The Fountain of Time” sculpture in 1920 uses these production techniques for a large-scale sculpture. (Figure 4) This project advanced Earley’s process further in his ability to control “the water-cement ratio in the molds at the time of set by means of an absorptive core, which as part of the mold extracted free water and permitted the concrete to be placed in one consistency and to set in another.”⁹⁷ The effectiveness of this system’s water removal and increased strength encouraged Earley to continue using this technique on later projects (one of which is the Nashville Parthenon which will be described later in this chapter).

This was the project that stirred the architectural community, earning Earley and his process of creating architectural concrete national attention. Both Earley and Lorado Taft, the sculptor of “The Fountain of Time,” were asked to speak before ACI’s annual convention that year. ACI followed his speech by awarding Earley the Mason Medal for most meritorious paper of the year. ACI members jumped at the chance to question Earley on the specifics of his technique; he would answer,

Periodically we do something in the surface treatment of concrete which seems to be interesting and encouraging and which you kindly write me to describe. On these occasions, I always bring to you the same message, namely; that concrete has in itself and of its own nature properties, which if

⁹⁶ Ibid.

⁹⁷ John J. Earley, “Architectural Concrete of the Exposed Aggregate Type,” 252.

skillfully developed and controlled, will make it the most satisfactory architectural and artistic medium ever known.⁹⁸

Earley wanted the material to be recognized and respected by the architect more than he wanted recognition for his contributions; his passion for such a material is what continued him forward despite his initial and immediate successes.

Polychrome and the Plastic Mosaic

After his success with Meridian Hill Park and the Fountain of Time, Earley was asked to lead a number of projects. Not only were these architects interested in Earley's meticulous study and use of a durable and appealing architectural concrete, but they knew that when they hired Earley and explained to him their intentions, Earley would use all means to pursue a reasonable and economical solution. Such was the case when architects Murphy and Olmstead and the Roman Catholic Church of the Sacred Heart, sought Earley's assistance to produce polychrome murals for a new basilica in Washington, DC.

Murphy and Olmstead recommended a church in the form of a Romanesque vaulted basilica, to mirror those of the Northern Italian Renaissance. However, they needed to recreate such a design with more economical materials than their earlier reference. They feared that it might be impossible to vary the color and produce the symbolic designs of a Romanesque basilica using concrete. However, after hearing of the great workmanship and attention to detail at Meridian Hill Park, they brought their problem to John Earley in 1922. Earley immediately "studied the records of those buildings which are the accepted works of

⁹⁸ John J. Earley, "Building the Fountain of Time," *Journal Proceedings of the American Concrete Institute* 19, no. 1, (1 January 1923): 190.

reference in style, analyzed the values, the relative importance of the various motifs and planned the optical sensations, which should be produced by the forms, colors, and quality of the surface.”⁹⁹

Earley determined that to achieve such lavish polychrome detailing, the aggregate must be chosen after careful consideration in terms of its durability and color and placed in an arranged design into the mold. The Earley Studio studied the color effects of certain aggregates, developing a comprehensive list of the most durable and colorful aggregates – amounting to over two hundred colors.¹⁰⁰ Earley also altered his technique once again to apply the colored aggregates in planned designs, experimenting with smaller precast panel samples before deciding upon an adequate technique. The Earley Studio arrived at the following solution:

The workmen transferred outlines of the design to a flat plaster of Paris slab and then carved narrow grooves in the soft plaster following the pattern. A casting was made from the carved slab with thin ridges separating the different parts instead of grooves. The workers placed in a half-inch layer, each color separated from its neighbors by a narrow ridge of plaster. For strength, this thin layer of concrete was backed up by a two inch layer of ordinary gravel concrete reinforced with galvanized steel mesh. Absorptive newspaper was laid on the backing concrete to extract the surplus water from concrete, speeding up the setting time. Finally, Earley’s men lifted the casting from the mold and exposed the colored aggregate by hand-brushing with steel brushes.¹⁰¹

Thus, Earley achieved polychrome coloring by applying technical control of the aggregate by means of raised plaster contour lines in the molds, permitting the simultaneous

⁹⁹ Cron, 21.

¹⁰⁰ John J. Earley, “Decorative Concrete,” *Engineers and Engineering* 48, no. 7, (July 1931): 160.

¹⁰¹ Cron, 23 – 24.

casting of many different colored aggregates – keeping them separated and in their own place without losing anything of unity in the mass of concrete.¹⁰² He applied the same form lining and gap-graded aggregate techniques that he had patented just two years earlier; thus, his combined processes produced panels of high early strength, uniform color and texture and an unprecedented density at the surface of the concrete mass. He termed the completed church panels “concrete mosaics,” as it mirrored the Italian mosaics of earlier tradition – but in a more economical and facile manner. (Figure 5)

Achieving this meticulous craftsmanship of detail in design and layout, Earley encouraged the development of this technique and material. He urged architects, once again, to accept it as a material that can not only achieve architectural sophistication but can do so in an economical manner. He predicted the material’s lasting influence.

A new building material, one of major importance, after it has gone through its novitiate and has been accepted usually begins to exert influence, to give its own character to the work in which it is used. That concrete will be no different in this respect from other materials is proved by those artists and architects who are using surface treated concrete to a considerable extent. Certainly we may expect concrete buildings both in their structure and appearance to develop an individuality equally as marked from that of standard masonry as the latter is from frame.¹⁰³

The Separation of Structure and Finish

In 1924, Earley was asked to develop architectural concrete for two large commissions: the rebuilding of the Parthenon in Nashville and Louisiana State University. (Figures 6 and 7) It is during these two projects that Earley redefined his technique for

¹⁰² John J. Earley, “Architectural Concrete of the Exposed Aggregate Type,” 253.

¹⁰³ John J. Earley, a. “Architectural Concrete,” *Journal Proceedings of the American Concrete Institute* 20, (1924): 167.

creating decorative concrete in precast panels. Since he began his work, he always stressed the commonality between stucco and architectural concrete, identifying both as “finishes” and separating them from the structural skeleton of the building; it is in these two projects that Earley masterly demonstrates this separation between structure and finish by creating the finish in the shop on its own piece of non-structural concrete.

For the Parthenon in Nashville, Earley was asked to create decorative exposed aggregate surfaces for every portion of the site. After discussing the project with architect Russell Hart and the Nashville Park Commission, Earley suggested a complete separation of structure and finish, the former accomplished by “modern high-speed mechanized construction methods in structural concrete” and the latter by “Earley’s highly-skilled workmen using extremely accurate molds and costly materials.”¹⁰⁴ Therefore, metopes were cast and exposed in the Earley Studio in similar fashion to the polychrome panels for the Church of the Sacred Heart; galvanized steel anchors were embedded in the panels so they could later be attached to the structural concrete architrave.¹⁰⁵ Since the metopes could be designed under careful supervision within the Studio, they posed little to no problems during production and application. Earley decided to treat the architraves, cornices and pediments with a stuccoed surface; since he had already developed a procedure to do so from Meridian Hill Park, there were no issues involving this application. For the columns, however, Earley needed to adjust his technique to apply a decorative surface to fit around the structural skeleton of the round elements.

¹⁰⁴ Cron, 31.

¹⁰⁵ Cron, 33.

Around the reinforced concrete columns, the Earley Studio built eight inch thick, hollow drums of ordinary gravel concrete as a base for the architectural concrete finish. The drums had a rough, porous texture designed to absorb the excess water from the surface concrete as well as an ideal state for the attachment of the finish.¹⁰⁶ Thus, Earley used an absorptive core to create a high early strength in the decorative finish, as well as created an adequate surface that would ensure proper adhesion of the architectural concrete shell to the core. (Figure 8)

This project was most likely the catalyst for Earley's work on LSU's campus later that same year. Earley argued: "Why not build the structural parts of the buildings of reinforced concrete, for which ample supply of contractors, labor, and materials was available in Louisiana, and then apply a finish of costly materials applied by highly skilled workmen imported into the state for this purpose?"¹⁰⁷ Campus authorities and architects, after seeing the successful separation of structural form and finish at the Parthenon, hired Earley to do the stucco work for most of their campus buildings.

The architectural profession and construction industry were slowly adopting the technical measures which allowed Earley such success in both permanence and aesthetics. Each year, Earley was asked to write and discuss his projects, as these were wildly popular among ACI members. Earley was rising as the chief consultant for architectural concrete, and the projects he received in the 1930s provided challenges which he addressed by evolution and adaptation of his already accepted practices.

¹⁰⁶ John J. Earley, b. "Architectural Concrete," *Journal Proceedings of the American Concrete Institute* 22, no. 2, (1 February 1926): 522.

¹⁰⁷ Cron, 35.

In 1932, members of the Baha'i World Faith had received enough funds to begin the exterior decorative shell of their temple in Wilmette, IL. They had been in contact with John J. Earley since the early 1920s when Earley agreed to create the concrete dome shell exterior which would then be placed over the steel skeleton structure. This was a departure from the prior applications of architectural concrete over the structure. The dome was a complicated design with hundreds of perforations so that light would enter into, and escape from, the temple interior. (Figure 9) Experience had led Earley to determine that such a thin, eggshell hemisphere design, being of such magnitude, would have to be completed by a series of precast panels, about 100 square feet in area, which would be connected by expansion joints that would allow differential movement between the cladding and the structure.¹⁰⁸ The Studio followed the same procedure they had used on previous projects.

The workmen filled the mold from the back or concave side and then vibrated the mold by tapping the edges with wooden clubs to make the concrete run into all the crevices. Then they applied the "capillary system", consisting of burlap and rags, to extract the surplus water. As the water was drawn out, the concrete in the mold stiffened noticeably; the workmen rapped forms again with their clubs, causing more water to rise to the surface, and this also was blotted up by the capillary system. This operation was repeated several times until the concrete would yield no more water, and then casting was then left to harden overnight.¹⁰⁹

However, the intricate design posed problems for the Studio, as the detailed slabs could not withstand the suction problem Earley had experienced at Meridian Hill Park a decade earlier. The perforations weakened the slabs and cracking occurred after every casting.

¹⁰⁸ John J. Earley and Basil G. Taylor. *Building Structures and Methods of Producing the Same*. Patent 2,050,290. (11 August 1936).

¹⁰⁹ Cron, 43.

Earley realized he needed to modify his technique once again to increase the early strength of the concrete in order to resist the vacuum problem between the mold and the casting.

Our concrete is composed of materials generally grouped in three sizes, the large aggregate, the small aggregate, and the cement. [By changing] the size of the small aggregate, we extracted additional water, obtained the increased stability in the concrete, turned over the three-ton casts in twenty hours, removed the mold and exposed the aggregate. Exactly what we did was to increase the mean diameter of the small aggregate .0015...Our experience teaches that the new technique will control not only the strength of concrete, but its density.¹¹⁰

The Baha'i Temple also allowed Earley to further develop his thoughts on the permanence of his material. The Baha'i World Faith believed that their temples should last as long as building materials are meant to last, or even longer – as a tribute to their constant faith. Therefore, the trustees and Earley carefully chose materials to ensure the structure's permanence. Furthermore, studies were conducted to determine how to best attach the slabs to the structural system. Earley and the trustees agreed that attachment by means of stainless steel bolts cast into the corners of the panels would obviate any possibility that rust might damage or stain the white concrete.¹¹¹ Earley emphasized how he outlined the installation process for the panels in such a manner that “any piece can be repaired and, if need be, removed and replaced without disturbing any other piece. Furthermore, if the furring system through neglect should deteriorate to such a condition that it was advisable to replace it, it can be moved and replaced without disassembling the concrete dome. Indeed it

¹¹⁰ John J. Earley, “Architectural Concrete of the Exposed Aggregate Type.” *Journal Proceedings of the American Concrete Institute* 30, no. 3, (1 March 1934), 253 – 255.

¹¹¹ Cron, 45.

would be presumptuous to attribute to the steel structure and the concrete envelope an endurance greater than they can possibly possess.”¹¹² With this idea, Earley’s concept further evolved to address the separation of finish and structure and as well as the characteristic permanence of Earley concrete mosaics. (Figures 10 and 11)

The Integration of Structure with Finish

The adaptability of the Earley Process, as his technique for producing precast exposed aggregate panels were soon coined, to the detailing of the lacelike pattern at the Baha’i Temple was a remarkable feat that earned Earley even more acclaim. In 1934, ACI awarded Earley the Henry C. Turner Gold Medal for “outstanding achievement in developing concrete as an architectural medium.”¹¹³ Through the efforts of John J. Earley and his Studio, architectural concrete earned acceptance as a durable, cost-effective, decorative building material suitable for monumental structures, and Earley was respected both for his meticulous process and his ingenuity and adaptability in meeting his clients’ needs. Such respect came especially when architects Zantzinger, Borie and Medary asked Earley to apply his concrete mosaics to the interior domes of the U.S. Department of Justice Building. (Figure 12)

This project was yet another turning point in Earley’s career in which his technique needed to be adjusted to meet the specifications and structural design of a singular building. The architects specified that “the mosaic finish and the structural concrete connected with it shall be one. They shall be made at the same time and by the same contractor. The finish

¹¹² John J. Earley, “Architectural Concrete of the Exposed Aggregate Type,” 257.

¹¹³ Certificate of Henry C. Turner Medal issued to John J. Earley, 1934.

shall in no way be applied to concrete previously constructed.”¹¹⁴ This troubled Earley, whose past success with precast paneling stressed the importance of a clear division between the structural concrete skeleton of the building and the precast concrete finish. Nevertheless, he accepted the commission and began to study all possible ways to achieve the designers’ intentions.

Earley reasoned that the precast concrete mosaics should, as has always been done, be cast, exposed and cleaned in the Studio under the careful watch of skilled supervisors. Then there was the question of application; Earley, with the aid of Basil Taylor, now a master engineer, concluded that if the precast panels were thickened they might be able to act as the formwork into which the structural concrete could be poured, thus discarding the need for wooden formwork. Earley documented his Studio’s progress on this idea.

The mosaic concrete slabs were thickened from one to two inches. They were reinforced with electrically welded steel wire mesh designed for the load of structural concrete to be supported and for the handling to be undergone in the processes of prefabrication and shipment. Steel loops protruded from the back of the slabs. They were so arranged that the slabs could be temporarily supported by hangars from the floor above so that the structural reinforcements could be threaded through the loops mechanically to attach the surface slab to the structure.¹¹⁵

Earley reasoned that the strength now in the precast slabs would be able to carry some of the structural load of the system, and thus, the structural concrete could be lessened. The contractors, unconvinced that Earley’s panels were as structurally adequate as he hypothesized, did not alter the design of their structural system; studies later showed that

¹¹⁴ John J. Earley, “Mosaic Ceilings, US Department of Justice Building.” *Journal Proceedings of the American Concrete Institute* 31, no. 5, (1 May 1935): 560.

¹¹⁵ Ibid.

the ultimate strength of the concrete domes were 5000 psi, making the dome much stronger than it needed to be (it was specified at 3000psi). Thus, Earley's combination of structure and finish created the anticipated polychrome decorative domes while simultaneously eliminating the need for wooden formwork and producing a stronger structural system. It was an unprecedented accomplishment arrived at through careful study, planning, and experimentation within the Earley Studio, an accomplishment later implemented on the Edison Memorial Tower,¹¹⁶ where Studio-produced decorative exterior panels were used as left-in-place forms for the conventional cast-in-place reinforced structural concrete shaft. (Figure 13)

Concrete Paneling and Prefabrication

The idea that precast concrete panels could be part of a building's structural system intrigued Earley so much that he encouraged the use of precast panels in prefabricated housing projects in 1935. His material, he argued, allowed the economic buyer an aesthetic choice in the housing market made possible by "the almost perfect technical control which can be exercised over their fabrication in a shop or studio, in the ease with which they can be shipped and assembled and in the economies which they afford."¹¹⁷ Although the Earley Process was able to make prefabricated housing both durable and artistic in design, Earley needed to rethink how the precast exposed aggregate panels would be secured to one another and to the structural columns of the houses. Earley developed and patented a

¹¹⁶ John J. Earley, "On the Work of the Committee on Architectural Concrete of the Exposed Aggregate Type and the Thomas Alva Edison Memorial Tower." *Journal Proceedings of the American Concrete Institute* 34, (May 1938): 589 – 601.

¹¹⁷ John J. Earley, "Architectural Concrete Makes Prefabricated Houses Possible." *Journal Proceedings of the American Concrete Institute* 31, no. 5, (1 May 1935): 519.

fastening system in which “after setting the slabs, they were fastened at the joints, supported and tied to the foundation by small reinforced concrete columns. A special device, which attached them to the columns, allowed them to move in any direction independently of one another. The device consisted principally of dowels protruding from the back of each slab along the vertical edge where the columns closed the joint. Around each dowel was a piece of rubber hose about 1.5 inches long. The concrete columns held the dowel firmly excepting the portion which was in the rubber hose. That portion remained free to form an elastic support. Each slab, therefore, was supported by a number of flexible steel rods and was free to move with the expansion and contraction of the concrete.”^{118, 119} (Figure 14) Thus, Earley developed a system that not only maintained the integrity of the panels and the structure as a whole, but dealt with waterproofing and weather-tightening the vulnerable joints between the high density concrete slabs. Advertisements soon hailed this novel engineering device that “creates a perfect, waterproof structure.”¹²⁰

EARLEY, THE ACI PRESIDENT (1939)

By 1936, John J. Earley was a regular speaker and contributor at ACI and other architectural conventions. In 1936, the AIA awarded Earley the Craftsmanship Award “for meritorious and original work in the application of color to masonry and the development of a new technique for the decorative use of concrete; as a result of which the choice of materials available to the architect in this field has been enlarged by the addition of new and

¹¹⁸ Ibid: 524.

¹¹⁹ John J. Earley and Basil G. Taylor. *Building Structures and Methods of Producing the Same*. Patent 2,050,290. (11 August 1936).

¹²⁰ “Erecting the Walls of the Newest Prefabricated House,” *National Press Building, Washington DC*. (1935).

interesting possibilities and texture capable of great variety of effective uses.”¹²¹ Earley was always willing to discuss his projects in detail, identifying what he was asked to do and how he went about creating the designer’s intentions with architectural concrete. Not only was he constantly learning, but he was determined to allow others to learn from his work as well. He understood that his passion for concrete as an architectural medium would not progress to a globally-accepted level until other engineers, architects, craftsmen and scientists understood the material’s full potential as developed through the Earley Process. Therefore, with the endorsement of ACI, he formed Committee 412 on Architectural Concrete of the Exposed Aggregate Type, whose intentions were to study the durability of Earley’s precast paneling system and assess what measures could be done to improve its permanence. After careful analysis and discussion, this technical committee, composed of scientists, engineers and craftsmen, would “conform to a pattern of general policy designed by the board to extend the work to the largest possible number of persons who can be benefited from it.”¹²²

Peer professional recognition of his technical contributions in the field of concrete, combined with his determination to disseminate all possible technical and scientific information led to his election as ACI president in 1939. One of the most important contributions Earley had to the development of ACI was his belief in a more collaborative effort between ACI and AIA; the integration of ideas among scientists, engineers, architects, and craftsmen would be a necessary step to standardizing techniques and facilitating material quality assurance in concrete construction for buildings. In 1939, Earley organized a joint committee session with AIA to discuss concrete as an architectural medium. Several

¹²¹ Certificate of the AIA Craftsmanship Award awarded to John J. Earley, (1936).

¹²² John J. Earley, “On the Work of the Committee on Architectural Concrete of the Exposed Aggregate Type and the Thomas Alva Edison Memorial Tower,” 591.

architects presented their ideas and qualms in the use of concrete. Of particular importance to note here is the lack of communication that existed before Earley arranged this meeting. The speeches presented identified architects' hesitation in using architectural concrete due to the lack of information on its potential as a durable, permanent and waterproof material. They worried about discoloration, metal corrosion in the reinforcement, water absorption, cracking and asked "what waterproofing preparations, if any, should we use that will avoid marring the surface and accomplish a permanent wall that has color, surface texture and design?"¹²³ Earley was the final speaker which allowed him to answer all the questions AIA members presented before him.¹²⁴ This communication would not have been possible without the efforts of John J. Earley.

THE BEGINNING OF STANDARDIZATION

Earley further revolutionized the field of precast architectural concrete in 1938 when he began opening up his Studio, allowing companies to watch the craftsmen at work and learn the coveted "Earley Process." Earley began a licensing and training program, making the Studio "a center for the training and inspiration of other craftsmen with the vision, tenacity and courage to carry on in a field whose potential seems unlimited."¹²⁵ Earley encouraged the licensing and training of his patented work, sure that it would ensure quality work among companies and allow architectural concrete to become a global medium. Newspapers reported,

¹²³ Ely Jacques Kahn, "Concrete for General Architectural Use," *Journal Proceedings of the American Concrete Institute* 35, (April 1939): 351 – 354.

¹²⁴ John J. Earley, "The Characteristic of Concrete for Architectural Use," *Journal Proceedings of the American Concrete Institute* 34, (April 1939): 385 – 389.

¹²⁵ Charter Heslef, "Local Plant World Famous for Concrete Mosaics," *The Washington Daily News*. (6 August 1938).

Although he and his associate hold patent rights for the Earley Process, with traditional artists' prodigality, they encourage others to enter the field. Mr. Earley emphasized that only the process of controlling the mix within the mold, a hand operation, is new. The materials are the same architects have worked for centuries.¹²⁶

The first example of an application of Earley's training and licensing program to a major building of quality-controlled architectural concrete was at the David W. Taylor Model Testing Basin, in 1939, for the U.S. Navy. (Figure 15) The Earley Studio was responsible for the plastic mosaics (as the precast slabs of predetermined color and form were termed) for the main entrance lobby and for the walls and ceiling of the museum in the office building; these interior precast panels were applied directly onto the structural concrete and were "bonded securely to the concrete and tile walls by means of metal ties and grout filler."¹²⁷ Hugo Fischer, chief Naval engineer on the project, describes the production on the precast panels as

the placing of a facing of Portland cement concrete made with aggregate of desired colors in a specially made mold, backing the colored aggregate facing with plain aggregate concrete to the desired thickness for handling and setting, removing the panel from the mold as soon as it has the necessary strength for handling, sanding and brushing the face as the first step in cleaning off excess mortar and then acid washing the face until the aggregate is fully revealed and the colors of the design well brought out...the craftsmanship involved in carrying out the designs, all require the work of a genuine artist and an organization with years of experience and research extending even to the production of the aggregates.¹²⁸

¹²⁶ Ibid.

¹²⁷ Hugo C. Fischer, b. "Navy's New Ship Model Testing Plant," *Journal Proceedings of the American Concrete Institute* 35. (April 1930): 321.

¹²⁸ Ibid: 321 – 323.

This was the extent of the Earley Studio's work on the project. Although John J. Earley was engaged as technical consultant, the exterior surfaces of the shop, office and laboratory group of buildings, the fitting-out room, the turning basin building and the boiler house and sub-station building were faced with precast exposed aggregate, reinforced concrete panels by the Dextone Co. in New Haven, CT.¹²⁹ Dextone employees were trained in the Earley Studio, and Louis Falco, the company's executive, achieved the proper licensing to produce the panels prior to the start of the project.

The precast panels served as the outside form against which the structural concrete was cast; this system was chosen because it had been seen in Earley's earlier projects that the thicker structural precast slabs could be cast in much larger sections than thin slabs of stone, thus facilitating weather-tightness and allowing the jointing to be placed where desired for architectural effect. Earley supervised and inspected the process by which Dextone produced the panels, recommending proper proportions for the mix design. The resulting concrete had an average compressive strength of 7525 psi at 28 days.¹³⁰

Fischer outlined the development of the panels in his papers, noting how Dextone's production and application matched the Earley Process. The molds were constructed of wood, shellacked, lined with Masonite, and greased with animal fat and soapstone before casting to avoid sticking and allow the same mold to be reused – as outlined in Earley's

¹²⁹ Ibid: 323.

¹³⁰ Ibid: 324.

patent.¹³¹ The reinforcement and anchoring system follows the system used at the U.S. Department of Justice Building – with minor adjustments.

The reinforcement consisted of zinc-coated cold drawn wire welded into a 4 by 4 inch mesh was placed into the slab no less than $\frac{3}{4}$ inch back of the face of the panel on top of which was placed the backing mix...The back of the panels were gone over with a stiff fiber brush several hours after casting to roughen the bond...Anchor loops of galvanized strap iron with the ends hooked around the reinforcement mesh and the loop part projecting out of the concrete were also installed on 2-foot centers each way.¹³²

The aggregate was exposed by means of an electrically driven belt sand and then finished with a wire brush and a dilute acid wash; afterwards, “the proper degree of acid etching was then checked by an inspector” [most likely Earley].¹³³

Fischer gives the most detailed analysis of how the structural concrete is secured to the panels with anchor bolts and loops designed by Earley for the U.S. Department of Justice Building and used on this project.

The panels were set on mortar beds with quarter inch joints in the manner usual for natural stone. One end of a $\frac{3}{8}$ inch bolt was then secured to the anchor straps embedded in the back of the panel with a nut on each side of the strap. A nut which remained in place for mechanical bond and a cone which was later removed were threaded on the other end of the bolt, the cone serving as a spacer for the inside of the back forms. Another bolt was threaded into the base of the cone and passed through wales supporting the $\frac{5}{8}$ inch thick plywood back forming and the whole drawn up tight.

It will be noted that the face panels and back forms were secured by a line of bolts at 2-foot centers and 2-foot intervals...Later on tie bolts were installed

¹³¹ Ibid: 324 – 325.

¹³² Ibid: 325.

¹³³ Ibid.

passing through the joints between panels to hold the meeting edges in line, thus allowing pours up to 8 feet high.

The back forms were removed by backing out the stud bolt from the cone through the wales; the cone was then unscrewed and removed but the bolt from the panel anchor strap to the nut back of the cone remained in place for mechanical bond of the panel to the structural concrete.¹³⁴

The structural capability of the precast panels that Earley had suggested since 1932 at the Department of Justice was realized at this site, for “the degree of integrity of these panels with the structural concrete was also taken advantage of by allowing the half thickness as part of the structural strength of the building.”¹³⁵ Furthermore, the use of tie bolts to allow pours of up to 8 feet high was a revolutionary idea that caused great excitement in the development of taller structures with fewer joints and less bracing and formwork. This system became a foreshadowing of later development of post-war precast paneled high-rise structures.

THE LEGACY OF JOHN J. EARLEY (1940S)

An important project that reasserted the durability and permanence of Earley’s architectural concrete came in 1942, when the U.S. Navy requested Earley’s consultation on a new Naval Medical Center in Bethesda, MD. (Figure 16) This project was designed to use Earley’s precast exposed aggregate panels but instead of being used as forms for structural concrete, the panels would be backed with brick “to facilitate progress of construction, since using the panels as face forms involved delay to install back forms and to pour the backing

¹³⁴ Ibid: 327.

¹³⁵ Ibid: 328.

concrete after setting each course of panels before the next increment in height of the building could be undertaken, whereas the brick backing could follow directly around with the setting of each panel course.”¹³⁶ Furthermore, “the method of mounting the precast panels as an exterior facing, substantially free of the structural elements of the building, allows deformations in the frame of the building as a whole to take place without bringing undue stresses on the panels, since the movement can be taken up in the plastic caulked joints between the relatively small sections of facing.”¹³⁷

Before production of the panels was conducted, the Bureau of Standards wanted to assess the durability of Earley’s panels by testing them against freeze-thaw cycling; the desired panels were to produce “a dense, strong, and low water-absorptive product...averaging about 6500 psi at 28 days.”¹³⁸

First, panels from the Naval Model Testing Basin were used as test specimens. Fischer documents the test results.

The ten test specimens past through an average of 307 cycles of freezing and thawing before they reached a condition such that the value of the panel for facing would be utterly destroyed. The Bureau roughly estimated that four cycles of such freezing and thawing tests were about equivalent to an average year’s weathering in this climate, although it may be considerably more or less because the conditions of the tests in which the specimens were fully saturated are different from those occurring on a building where vertical surfaces might rarely be exposed to any considerable degree of saturation

¹³⁶ Hugo C. Fischer, a., “Architectural Concrete on the New Naval Medical Center,” *Journal Proceedings of the American Concrete Institute* 13, no. 4, (January 1942): 292.

¹³⁷ Ibid.

¹³⁸ Ibid: 293.

when freezing occurs. On the basis of the four cycles being equivalent to a year of weathering, the effective life on a building would be about 75 years.¹³⁹

An assessment of past Earley projects was then conducted to determine the longevity of the Studio's precast exposed aggregate panels. As Fischer recounts, "inspection was made of nine structures in the Washington area...as produced by the Earley Studio...the work as a whole was in remarkably good condition and all precast work was in excellent condition."¹⁴⁰ There was some cracking in the concrete panels at the Basin, but after intense study, it was determined that the cracking was due to "excessive pressures [that had] developed by pouring the vibrated backing concrete too high against these panels as forms [which caused] volume changes and cracking of the structural backing. It is noteworthy that where joints in successive courses of panels were offset as much as 9 inches and the backing concrete developed a continuing crack opposite one joint, the strength of the panels was sufficient to carry the movement the distance of the offset to the next panel joint instead of cracking through the panel directly opposite the crack in the backing concrete."¹⁴¹ Not only were Earley's precast panels not responsible for the observed cracking, but they were so durable as to withstand the stress induced by the developing cracks and simply translated the stresses alongside to the adjoining structural concrete. After these analyses, the Navy was certain that panels by the Earley Process would be the most durable, weather-resistant and permanent features for the structure.

¹³⁹ Ibid: 294.

¹⁴⁰ Ibid: 296.

¹⁴¹ Ibid: 297.

Three separate mounting systems were employed: attachment to structural steel, free-standing but anchored to concrete structural framing, and wall-bearing construction. The attachment to the structural steel was a new system that utilized older, Earley techniques. Setting lugs were run through the gaps to later be filled with brickwork and holes were drilled for anchorage dowels in the spandrels within these openings and filled with concrete and grout filler. For the freestanding concrete panels, an anchoring system similar to Earley's prefabricated housing system was used. Finally, for the wall-bearing construction, the system used at the Naval Model Testing Basin was implemented.¹⁴²

The satisfactory production and application of panels at the Model Testing Basin and the Naval Medical Center encouraged the rapid assimilation of Dextone Co. and other companies trained by the Earley Studio to the architectural concrete field. Louis Falco of Dextone, Co., decided to make precast exposed aggregate concrete available for industrial purposes by filing for registration of the trademark "MoSai" in December of 1939. "MoSai," as this material would be called for the rest of its life, referred to the mosaic appearance of the exposed aggregate precast cladding as made possible by the Earley Process. By 1940, the MoSai Institute was formed, responsible for training all affiliated members in the Earley technique.¹⁴³ Earley's dream of standardization and dissemination was becoming a reality.

¹⁴² Ibid: 305.

¹⁴³ Sidney Freedman, b., "History of Exposed Aggregate (MoSai) Architectural Precast Concrete," *PCI Journal* 48, no. 3, (May – June 2004): 26.

CONCLUSION

Over the course of thirty years, John J. Earley not only established a new vision for durable and attractive precast concrete; he led the architecture field in standardizing, training and licensing the production of his material. His material not only stands out for its unique ability to express color and texture but also for its qualities of permanence, strength and durability:

If at this point we may reminisce for a moment, it would be seen that everything that has been done to improve the appearance of mosaic concrete also improved the strength and permanence of structural concrete. When we separated the aggregate into two sizes and recombined it to the greatest density practically possible, it was done to obtain the greatest possible value from the color of the aggregate and to reduce to a minimum the interference from the color of the cement. But the same procedure increased the density of the structural concrete and reduced permeability to a minimum. When we extracted water from the mosaic concrete castings it was done to stiffen them so that they could be taken from the mold and surface treated before the cement had thoroughly set. In doing so we made a cement water paste which produced the strongest structural concrete. Therefore mosaic concrete possesses with its beauty a high degree of impermeability and strength.¹⁴⁴

Earley was so meticulous in his studies and experimentations that his material achieved its ultimate in design and application before there were tests devised that could validate it. Thus, except for minor adjustments in terms of reinforcement materials and anchorages throughout the remainder of the twentieth century, the Earley Process remains unchanged due to ability to create a durable, weather-resistant, and aesthetic precast concrete – which scientific studies in the following chapter will verify.

¹⁴⁴ John J. Earley, “Mosaic Ceilings, US Department of Justice Building,” 564.

CHAPTER 5: THE DURABILITY OF JOHN J. EARLEY CONCRETE

INTRODUCTION

As stated in the previous chapter, the standardization of architectural products was a natural step in the growth and quality of the field and the profession. Materials and processes would be predetermined based upon scientific study and experimentation – a key component of design emphasized by John J. Earley as early as 1914 at Meridian Hill. The advancements in scientific testing at the turn of the twentieth century allowed material scientists and designers to improve the quality of concrete and recommend design guidelines for precast paneling based upon experimental results; studies were also conducted to test the durability of existing concrete structures, particularly precast exposed aggregate concrete paneling.

The chapter will show how most of the technical recommendations in concrete design during the revolution in science and construction of the 1950s and 1960s had already been incorporated into Earley's methods and had been identified in his writings. His on-going studies on concrete's properties from 1920 to 1940, which led to the beauty and durability of plastic mosaics, were not only repeated in the post-war scientific studies but the superiority and intellect of his technique was confirmed.

In addition, although Earley was capable of producing an advanced, durable concrete product, it has been seen that the material is still subject to failure – as discovered in the preservation efforts on John J. Earley projects. Earley's process and product will be assessed in the analysis of the current restorations of some of his most known works to determine if

the deterioration stems from an inherent characteristic in Earley's design or from exterior factors – which will guide current preservation efforts when dealing with precast exposed aggregate concrete in assessing the material's durability.

SCIENTIFIC STUDIES FOR THE DEVELOPMENT OF PRECAST CONCRETE

Technical committees in groups such as the American Concrete Institute led experiments to assess the quality of precast concrete products; this period of study only increased with the advances in modern technologies at the turn of the century. In the decades following the patenting and licensing of the Earley Process, John J. Earley's ideas of producing a durable, permanent product were tested and validated.

During his career, Earley had insight into material development, insight that others would not discover and appreciate until decades later. For example, in his studies, Earley reiterated the need to connect modern advancements in concrete with the durability seen in the concrete structures of Antiquity. He attributed the durability of the monumental use of Roman concrete to the constant care and workings of the historic craftsman who “recorded what to do that the materials might be strong and enduring, how to keep out cracks, how to make each mix like every other mix and how to make the surface pleasing to the eye.”¹⁴⁵ Earley wished to mirror these ancient craftsmen and builders, who understood their material and knew that strength derived both from cement's interaction with water and time. This study of historic building technology led Earley down a particular path, a path that led him directly to his specialized process of producing precast elements. About forty years later,

¹⁴⁵ John J. Earley, “Time as a Factor in Making Portland Cement Stucco.” *Journal Proceedings of the American Concrete Institute* 23, no. 2. (1 February 1927): 473.

similar studies on historic mortars and cements validate Earley's beliefs. According to scientists at the International Symposium on the Durability of Concrete in 1961, durability and permanence is only achieved with the use of suitable materials, correct mixture proportioning, good mixing and excellent compacting, and suitable curing techniques. These scientists believed these qualities could be achieved by studying ancient Roman concretes and plasters; it was determined that the Romans added gray mortar and charcoal to absorb surplus water from the mortar layers during compacting and curing, increasing its strength and density. Therefore, removing all unnecessary water from the mix during compaction and setting is necessary for a strong and durable concrete.¹⁴⁶ This statement made in 1961 is virtually identical to the results of Earley's tests in 1924.¹⁴⁷

The 1950s and 1960s saw a rapid development in precast panels, both as structural features and as cladding. One of the key scientists identifying the performance capacities of these wall panels in the 1960s was Victor Leabu. Aware that "a standardization of design practice or a recommended design guide has yet to be developed for this unique type of construction material [and] only past experience and experimentation have been the key to the design standard used for development of the precast wall panels,"¹⁴⁸ Leabu established some guidelines verified by experimentation and scientific analysis in accordance with the newly established ACI Committee 533 "Precast Panels". Leabu identified the many advantages to precast panels, namely that their "light weight, speed of erection, resistance to

¹⁴⁶ R. Malinowski, A. Slatkine, and M. Ben Yair. "Durability of Roman mortars and concretes for hydraulic structures at Caesarea and Tiberius." *RILEM Final Report of the International Symposium: Durability of Concrete*, 1961.

¹⁴⁷ John J. Earley, "Time as a Factor in Making Portland Cement Stucco." *Journal Proceedings of the American Concrete Institute* 23, no. 2. (1 February 1927): 473.

¹⁴⁸ Victor F. Leabu, a. "Precast Concrete Wall Panels: Design Trends and Standards." *ACI Special Publication* 3. (1 January 1965): 31

wind, rain and fire and low initial cost with minimum maintenance have sparked the enthusiasm of architects, engineers, builders and the public.”¹⁴⁹ His studies acknowledge the need for a standard method to produce a uniform color and texture based upon a rigorous control of concrete and its ingredients and recommends that in order for precast panels to be durable, the allowable compressive strength of the panel should be ranged between 3000 to 5000 psi.¹⁵⁰ This is corroborated by another study in 1963 that suggests a compressive strength of at least 5000psi for thin precast exposed aggregate cladding, which “allows early stripping and reuse of forms and more satisfactory attainment of architectural finishes. The influence of high compressive strength on durability is accomplished through the associated property of low permeability.”¹⁵¹

Leabu also suggested a low absorption rate for the exposed panel, more lateral movement for thinner panels and proper jointing.¹⁵² These characteristics were previously specified in Earley panels seen at the Naval Medical Center whose low absorption rate was capable of resisting over 300 freeze-thaw cycles. Earley’s patented jointing system seen at the Baha’i Temple in 1933 was designed specifically to allow for lateral movement and proper jointing between panels, and the Temple trustees and Earley avoided using brittle materials for just the same reasons as Leabu discusses. Finally, all studies on Earley’s panels undertaken in the mid-twentieth century had compressive strengths ranging from 5000 to

¹⁴⁹ Victor F. Leabu, b. “Problems and Performance of Precast Concrete Wall Panels.” *Journal of American Concrete Institute*. (October 1959): 287

¹⁵⁰ Victor F. Leabu, a.: 40

¹⁵¹ J.A. Hanson, “Tests for Precast Wall Panels.” *Journal Proceedings of the American Concrete Institute* 61, no. 4. (April 1960): 130.

¹⁵² Victor F. Leabu, a.: 288 – 297.

7250 psi!¹⁵³ Earley had identified all these necessary components thirty years before Leabu's studies.

The constant testing conducted of the 1940s led to the publication of material standards of production in the 1950s. The first design standards for the production and application of thin precast concrete panels recognized the need for "rigidly controlled operations comparable to planned factory production"¹⁵⁴ – identifying the controlled craftsmanship quality seen at the Earley Studio that was necessary for producing superior products. Although it does not explain the artistic component of exposing the aggregate, the guidelines suggest that "cold drawn steel wire in the form of wire mesh reinforcing, preferably of 2 inch spacing, is recommended...preassembly of such reinforcement into cages by a template or jog before placing in the forms is recommended. [Furthermore,] the casting procedure should be such that thin sections are cast in the horizontal position with open-top forms to facilitate placing and compacting the concrete."¹⁵⁵ All these recommendations agree with what the Earley Studio had been doing since the 1930s.

THE DURABILITY OF EARLEY'S PRECAST PANELS

The scientific studies developed after the war confirmed the durability and permanence of the Earley Process. However, more influential than any study is the living testimony of John J. Earley's enduring projects. The rapid interest in Earley's technique

¹⁵³ Fischer, Hugo C. a. "Architectural Concrete on the New Naval Medical Center." *Journal Proceedings of the American Concrete Institute* 13, no. 4. (January 1942): 289 – 311.

¹⁵⁴ Amirikian, Arsham. "Tentative Recommendations for Thin-Section Reinforced Precast Concrete Construction." *Journal Proceedings of the American Concrete Institute*. 29, no. 11 (May 1958): 922.

¹⁵⁵ Ibid: 925.

from 1920 to 1960 was documented by the many visitors of his projects. On October 16, 1926, F.R. McMillan, the Manager of the Structural and Technical Bureau of the Portland Cement Association, wrote a letter to a colleague, stating, “I had the pleasure of visiting the Parthenon at Nashville and I must say that both the appearance of the structure and the character of the surface as regards resistance to weathering greatly exceeded my expectations. It leaves nothing to be desired in either respect.”¹⁵⁶ Hugo Fischer’s account in the 1940s of the studies undergone for the new Naval Medical Center notes that “inspection was made of nine structures in the Washington area on which exposed aggregate concrete, as produced by the Earley Studio, was used, ranging in age from Meridian Hill Park to the Normandy Building built in 1938 [four years prior to the study]. While some minor defects were noted, the work as a whole was in remarkably good condition and all precast work was in excellent condition.”¹⁵⁷ Even in the 1960s, studies of precast concrete panels were not complete without an assessment of those structures already in existence. Many times the Baha’i Temple was cited as a site “providing direct evidence of the durable quality of precast panels.”¹⁵⁸ Earley’s projects have stood the test of time, indicative of the superior quality of design in its production and implementation.

By the 1980s, the use of precast exposed aggregate concrete in post-war construction was seen throughout the country. Advocates used its continued durability and weatherability – as made possible by Earley and the Earley Process – to champion for its continued use.¹⁵⁹

¹⁵⁶ Correspondence on October 16, 1926, from F.R. McMillan, the Manager of the Structural and Technical Bureau of the Portland Cement Association, Courtesy of the Cron-Earley Collection, Georgetown University.

¹⁵⁷ Fischer, a.: 296.

¹⁵⁸ Hanson: 130.

¹⁵⁹ Muriel Burns, “Advantages of Exposed Aggregate in Visual Concrete” *Concrete International*. (January 1980): 50 – 55.

Today, there are many ways to produce an exposed aggregate finish on precast concrete panels. However, as much as the industry advances, some things remain the same. A recent study completed in 2001 by PCA on precast concrete panels built in the 1930s identifies the durability of the technique Earley fathered.

Much has changed since the panels described in this report were built. Yet many of the methods used to create these attractive concrete surfaces are still around today because they are effective. The basic processes of bringing out the best appearance of concrete walls remain similar to their original methods.¹⁶⁰

While Earley's projects are testaments to his life-long career of perfecting a process to produce an architecturally sophisticated, enduring product, the material has still been subject to deterioration and extensive material damage. The recent restoration efforts at Meridian Hill, the Nashville Parthenon, the Baha'i Temple and the Edison Memorial Tower have added insight into the causative factors of deterioration seen in Earley's works. It has been discovered that these problems stem from factors like reinforcement corrosion and improper jointing and sealing – issues not inherent to Earley's product or process but from exterior sources such as the limited technology and knowledge in design of his time. The diagnoses for each project, explained in the following section, validate the effectiveness of the Earley Process at achieving a superior quality concrete.

¹⁶⁰ Panarese, William C., Albert Litvin, and James A. Farny. *Performance of Architectural Concrete Panels in the PCA Outdoor Display*. Skokie, IL: PCA Publication, 2005.

THE DETERIORATION OF EARLEY’S PRECAST PANELS ¹⁶¹

The recent restoration and preservation of John J. Earley projects investigated the science behind the Earley Process to determine whether the deterioration exhibited at these sites was inherent to Earley’s patented procedure or developed from other, external forces. Since the last decade of the twentieth century, major restoration campaigns have been undertaken at four of John J. Earley’s most known sites: Meridian Hill Park in Washington, DC, the Nashville Parthenon, the Baha’i Temple at Wilmette, Illinois, and the Edison Memorial Tower in Menlo Park, New Jersey. The production and application of Earley’s precast exposed aggregate concrete for each project has already been explained in Chapter 4; the following section will outline the preservationists’ findings as to the actual causes of deterioration. Although all the sites have a unique aspect of John J. Earley’s innovative material, the deterioration mechanisms responsible for concrete degradation stem from the same factors. It will be seen that these factors do not proceed from Earley’s predetermined mix and design specification but from limited knowledge in the design of proper reinforcement, joints and sealing – factors that Earley could not recognize as potential flaws because they were still in their initial stages of development during his testing. It will be seen that Earley carefully outlined his program with the knowledge he had gained to create a durable and permanent material but was still limited by the technology and knowledge of his time.

¹⁶¹ This is a general overview of the conditions assessment of each restoration campaign as provided by Robert Armbruster of *The Armbruster Company*; Michael C. Henry, PE, AIA; and the following texts: Lori Aument, “Construction History in Architectural Conservation: The Exposed Aggregate, Reinforced Concrete of Meridian Hill.” *Journal of the American Institute for Conservation* 2, no.1 (Spring 2003): 3-19 and Ilene R. Tyler, "Replicating the John J. Earley Concrete Mix to Restore the Nashville Parthenon" *APT Bulletin* 35. (2004): 43 – 50.

Deterioration Mechanisms

The conditions assessment undertaken at Meridian Hill Park in the 1990s identified moisture penetration as the leading cause of deterioration of John J. Earley concrete. Although most of the concrete was identified as remarkably good condition, some concrete was severely damaged from factors including the corrosion of the reinforcement, freeze-thaw cycling, and physical stresses.¹⁶² Efflorescence was evident in some places, verifying the presence of a moisture issue, for water penetration through the concrete was leaching out carbonates and depositing them on the surface in the form of efflorescence. It also appeared that moisture was leaking in through the concrete joints and finding its way to the reinforcement behind the front face of the concrete, whose exposed aggregate surface provided a low absorption rate. This deterioration will be explained in more detail following because these conditions were also seen on other Earley sites, such as the Nashville Parthenon and the Baha'i Temple.

The Nashville Parthenon and Baha'i Temple were both suffering from similar concrete deterioration in the form of moisture issues. Water was penetrating through the joints of the panels and corroding the internal metal mesh reinforcement at the Parthenon – to the point that major concrete spalling was occurring.¹⁶³ This is concurrent with the issues of trapped moisture, joint deterioration and efflorescence seen at the Baha'i Temple at Wilmette, Illinois. Here at this site, the moisture is finding its way to the reinforcement in between the joints, causing extensive corrosion and concrete spalls in the already thin,

¹⁶² Lori Aument, "Construction History in Architectural Conservation: The Exposed Aggregate, Reinforced Concrete of Meridian Hill." *Journal of the American Institute for Conservation* 2, no.1 (Spring 2003): 3-19.

¹⁶³ Ilene R. Tyler, "Replicating the John J. Earley Concrete Mix to Restore the Nashville Parthenon" *APT Bulletin* 35. (2004): 43 – 50.

intricate lace-like designs on the temple's dome. These conditions are identical to the moisture issues most recently witnessed at the Edison Memorial Tower.

Moisture penetration through the panels' joints at the Edison Memorial Tower at Menlo Park is leading to the deterioration of John J. Earley concrete. The moisture that finds its way through the joints is corroding the wire mesh in the panels, causing the reinforcement to bleed through the concrete. Concrete spalling is also occurring due to the corrosion of the hoop bars that are positioned between the wire mesh and the outer surface of the panels, and this corrosion is causing section of the bars' thin concrete cover (less than an inch in the two inch slabs) to break off. Moisture through the joints, once again, appears to be the main deterioration mechanism responsible for the failure of John J. Earley concrete.

*Possible Reasons for Failure*¹⁶⁴

The possibility of moisture penetration, which leads to the internal corrosion of the steel reinforcement, is caused by the implementation of jointing techniques not fully matured at Earley's time combined with the superior durability and weather-resistance of Earley concrete. Since it has been confirmed that the front face of the exposed aggregate panels have relatively low water absorption capacities as tested at the Edison Memorial Tower, the water is gathering at the joints between the panels, which are sealed with a cork and mortar and later caulked.¹⁶⁵ These joints, which are tilted upward, do not drain water very well, and

¹⁶⁴ This analysis is based upon the conditions exhibited at the Edison Memorial Tower, gathered through correspondence with Michael C. Henry, PE, AIA, on April 27, 2008. Therefore, it can only act as hypothetical reasons for failure at the other sites – since all the sites are exhibiting similar conditions and deterioration.

¹⁶⁵ Ibid.

the water that enters the joint may be quickly absorbed by the more permeable back facing of the panels. The thickness of the structural concrete behind the front panels does not allow the moisture to leave the panels from the interior of the structure; therefore, the water must dry to the outside through Earley's densely packed concrete, where it then comes in contact with the metal reinforcement.

The deterioration of Earley concrete, therefore, does not directly stem from the inherent composition of Earley's design, but rather from factors that were limitations of the time. The jointing in between the panels during Earley's time was a novel design, especially with tall structures. Precast panels today have a double seal with weep holes or other provisions for adequate water drainage. Earley could not have accounted for this jointing weakness because a mature understanding of this technique was not fully established. Similarly, the reinforcement of the age could potentially be flawed. There is no information on what John J. Earley used exactly in terms of reinforcement – although Fischer does explain in his article that "... a welded wire mesh of quarter inch diameter steel wires on 4-in. centers each way, this reinforcement being made of galvanized wire and dipped in hot pitch after all forming, cutting, and welding is completed."¹⁶⁶ If Earley's reinforcement were hot-dipped galvanized wires, possible flaws built into this reinforcing system could include inadequate coating at the welded areas and an uneven coating during the hot-dipping process, which would make the reinforcement more susceptible to corrosion in the presence of moisture. One potential flaw that was part of Earley's design, however, was the thinness of Earley precast panels (approximately two inches), which may not have provided the reinforcement with proper cover (as seen where concrete has spalled at the hoop bars at the

¹⁶⁶ Hugu C. Fischer, a, 293.

Edison Tower). Although Earley inspected every panel he designed, he could not have foreseen these possible failures because he was limited to the knowledge of design at the time.

The diagnostic assessments at the Earley sites validate the adequacy of Earley's process and product. The failure of John J. Earley concrete has been the result of metal reinforcement corrosion, water penetration in the joints and support detailing. These exterior factors were not primarily the fault of Earley's design or process; it was that Earley began his studies at a time when these design parameters were in their initial, crude stages. Earley challenged his field but could only go so far with the materials to which he had access; thus, John J. Earley concrete is a durable, low permeable aesthetic material that is a victim of collateral factors that were the limitations of his time.

CONCLUSION

Earley's advanced understanding of the material led to a sophisticated process of producing a beautiful and durable building component. The superiority of his systematic procedure was recognized and acknowledged in the years, tests and conferences following his career. However, as has been discovered during the restorations of Meridian Hill, the Nashville Parthenon, the Baha'i Temple and the Edison Memorial Tower, even though Earley's product was refined, it was still held within the limits of its time. Most problems stem from the jointing system – which was still in its crude stages of development. Although Earley attempted to make strides in terms of jointing and creating a weather-tight seal between the panels, the technology available to him still left something to be desired. The deterioration seen at these sites are all external factors, separate from the concrete's

durability as made possible by the Earley Process. Thus, the process patented by Earley in 1940 was a unique, sophisticated shift in thought that was a vital component to the development of precast concrete. It will be seen that except for minor adjustments, the same Earley Process continued to be used in the precasting industry after World War II - and is still used today.

CHAPTER 6: POST-WORLD WAR II PRECAST CONCRETE CLADDING

INTRODUCTION

Ornamental precast became popular by the end of the 1920s, but with the accelerated technical advances following WWII, interest soon turned away from ornate surfaces and imitation stone. The focus was then on reinforced concrete with its long span construction of large uninterrupted areas and experimentation with eye-catching forms. The emergence of reinforced concrete as industry's preferred construction medium satisfied the nation's need for an inexpensive building material that could be erected quickly and with cheap labor. Nevertheless, there was a place for precast concrete as new technologies, such as the construction crane capable of lifting heavy building elements to greater heights, allowed for the rapid development of large scale buildings composed entirely of precast. While economies of design were paramount at this time, the aesthetic appeal of buildings was still possible. With the patenting and licensing of the Earley Process, the construction world attempted to recreate the aesthetic and durable design seen in Earley's projects of the 1930s.

This chapter chronicles the production of precast exposed aggregate concrete in post-war construction and identifies John Earley's lasting achievements in the development of precast architectural concrete. It will do so in following the development of Earley's product from a hand-crafted material to a mass-produced building component iconic of the 1960s and 1970s. It will be seen that although the concrete community refined their techniques in terms of standardization, the precast exposed aggregate panels were and still are made in an almost identical manner to the original Earley Process. However, despite

post-Earley MoSai structures' adherence to the same Earley method patented in the 1940s, part of Earley's craft was lost in the development of mass production systems.

The chapter will then highlight some of the more general, mass-produced MoSai buildings and assess their imprint (or lack thereof) on the architectural achievement of concrete as an aesthetic material (as compared to Earley's work) to determine what affect, if any, mass production has had on Earley's craft. Although the economies of Earley's method were fully embraced, it will be determined if the mass production of precast paneling has lost the craft of the individual artisan that truly made Earley's projects, which will then determine what preservation efforts are appropriate when dealing with Earley's work and if the level of effort differs when dealing with later mass-produced MoSai structures.

THE EARLEY STUDIO AFTER WORLD WAR II

When the Second World War hit American industry, emphasis shifted from architecture as a craft to architecture as a practical and economical design that would best benefit the war effort. Accordingly, the Earley Studio adapted their work in the precast industry to the current needs of the country. The studio's artistic expression was rare, limited to small governmental maps and signs during the time. (Figure 17) However, this was not the end of concrete for architectural purposes; in the years following the World War II, the Earley Studio will once again prove the enduring benefits and adaptability of precast exposed aggregate concrete panels to the economy's shifting needs.

The Earley Studio's continued work during and after the war was heralded as a vital and ingenious advancement in concrete design and use. John Earley's and Basil Taylor's encouragement of other companies to learn the trade further advanced the field. Soon, the Earley Studio was known nation-wide; trades journals and magazines readily advertised the Earley Process of producing plastic mosaics. These precast elements were noted for their freedom of design in size, shape, texture and color, their effective reduction of joints and flashings which, in turn, reduced leakage threats, their strong yet slender properties, the reusability of their forms, and their practical economy.¹⁶⁷ Another article referred to the Earley Studio as the company responsible for broadening the realm of concrete work and, thus, opening "limitless views"¹⁶⁸ in product development.

In 1945, John J. Earley died leaving the Studio to his partner Basil Taylor and Taylor's son, Vernon. The Studio continued its work in the same manner as Earley had originally done.

At the Rosslyn Plant, complete facilities were available for the grinding and sizing of aggregates. Quartz stone carefully selected for its color, density and durability, was crushed in a Sturtevant 8 by 10 inch jaw crusher. A Tyler rotating screen and a Tyler hummer two-deck vibrating screen were used for sizing. The prepared aggregates, ranging from 1.5 inches maximum in dimension to finely ground sand, were stored in bins within bags or in bulk, depending on the amounts being handled.

The mosaic concrete facing is mixed in the approximate proportions of 94 pounds of Atlas white cement, 110 pounds of fine aggregate, 300 pounds of coarse aggregate, and 5 gallons of water. Both the coarse aggregate and the fine aggregates are carefully blended to produce the required color. The

¹⁶⁷ "Architectural Concrete Slabs," *Bulletin of the Producers' Council*, (AIA File: 1939).

¹⁶⁸ William M. Avery, "Earley's Mosaic Concrete Opens Limitless Vistas in Products Field," *The Concrete Manufacturer*. (September 1944): 131 – 134.

Studio has always used Atlas white cement from the North Hampton Plant to assure a uniformly white matrix that will bring out the full color of the exposed aggregate.

The slabs are made face downward, and the mosaic decoration is accomplished by placing ridges about an eighth of an inch high on the plaster forms of the mold to mark the lines between the various colors of the design. The colored mixtures are then placed in their proper positions in the mold to a depth of about three-quarters of an inch, wire-mesh reinforcing is placed, and the mold is filled to the required depth with ordinary sand and gravel concrete of the same proportions as the facing.

The excess water in the mix is removed by absorption and vibration after the materials are in place. It has been found that additional water may be removed from apparently dry concrete by a second application of absorptive materials accompanied by vibration without disturbing the granular arrangement of the aggregate.

After standing for 12 hours, the cast is removed from the mold and the exposed face is scrubbed with wire brushes to remove the surface cement and expose the aggregate. The full brilliance of the colors is brought out by bathing the surface with a weak solution of muriatic acid. The casts are cured in a humidity-controlled chamber for 14 days, from which they emerge with a flint-like surface and crushing strengths as high as 7500psi.¹⁶⁹

Plant specifications dating back to 1951 indicate that “samples of Earley Process Plastic Mosaics, showing color and finish shall be submitted to the Architect for approval. None of the work under this contract shall be commenced until such approval has been obtained.”¹⁷⁰ The panels were designed two inches thick of a facing concrete of Portland cement and crushed quartz or granite aggregates placed within the wooden mold according to the predetermined pattern. The various aggregates were separated from one another by

¹⁶⁹ Ibid, and “The Earley Studio Incorporated: History.” Printed Manuscript. Date Unknown. Courtesy of the Cron-Earley Collection, Georgetown University.

¹⁷⁰ The Earley Studio, Incorporated. “Earley Process Plastic Mosaics Applied: Specifications.” (17 May 1951).

plaster ridges placed in the mold. Reinforcement, in the form of steel drawn wire mesh welded into a single unit, was held in the mold and kept an inch away from the edges and exterior surfaces of the panel. Anchorages and anchor loops, exactly as Earley had placed into his precast slabs twenty years earlier, were welded to the wire mesh reinforcement. The concrete backing consisted of a normal, standardized mix of structural concrete and roughened after set to an approved texture. As compared to his process employed at any of the projects previously cited, Earley's method for producing the exposed aggregate concrete facing was unchanged since the 1930s, save for improved machinery.

After Basil Taylor's death in 1952, the Earley Studio joined with Marietta Concrete Corporation in Marietta, OH, to become a large-scale manufacturing corporation. At the time, Marietta was developing the fabrication and installation of structural, fully insulated, curtain wall concrete panels; these "sandwich panels provided the construction industry with a precast concrete panel capable of competing with thin-metal curtain walls in weight, cost and insulation efficiency."¹⁷¹ (Figure 18) Although they perfected a new structural slab, Marietta wished to apply an aesthetic finish to their plainly-finished concrete panels and thus, sought the craftsman technique of the Earley Studio. In 1954, the two companies merged and implemented the Earley Process to produce structurally-sophisticated, exposed-aggregate precast slabs. The natural marriage of the two companies led to an explosion in projects across the country. The increased demand forced the Earley Studio to open business offices in New York City, Philadelphia, Pittsburgh, Boston and Buffalo, and Marietta to open a new plant in Baltimore. As one historian recalls,

¹⁷¹ Victor F. Leabu, "Precast Concrete Wall Panels: Design Trends and Standards." *ACI Special Publication* 11, (1 January 1965): 32

Since 1955, there has been a tremendous increase in the use of precast concrete panels of all types, and a concurrent growth in the development of textures and patterns. Reasons for this expanding usage include improved methods of production, better handling and erecting equipment, and development of new techniques and materials...It may be interesting to note that while these panels are rectangular in shape, by proper placement of the colored facing mixes it has been possible to create a harlequin diamond pattern [and other] abstract representations.¹⁷²

While this description does not cite Marietta or the Earley Studio directly, it does highlight how the collaboration of a structurally-enhanced panel with plastic mosaics led to the development of further manipulation of precast concrete's aesthetic abilities and a growing demand for this product.

The increasing interest of Earley's plastic mosaics led the company to relocate to a larger facility in Manassas, VA, in 1962. The operations continued to expand, and the Studio grew in both reputation and physical footprint. The company was the leader of precast concrete paneling until the Studio went out of business in 1973; however, this was not the end of precast exposed aggregate paneling or of the Earley Process. The growing demand in post-war construction saw the emergence of an industry devoted solely to precast concrete products – an industry of competition and expansion of trade originally encouraged by Earley in 1938 when he first opened up his Studio to other company owners.

BEYOND THE EARLEY STUDIO

When concrete cladding emerged as the main building medium in the years following the Second World War, the use of concrete block and imitation stone declined. Companies

¹⁷² T.W. Hunt, "Precast Concrete Wall Panels: Historical Review." *PCI Papers No. 1*. (Date Unknown): 5, 10.

that devoted their careers to concrete block construction looked for other concrete production methods. In 1959, the Indiana Limestone Corporation sought licensing from Earley to manufacture precast concrete under the Earley Process; the Earley Studio entered into a 20-year agreement with the company that allowed the Studio royalties for each square foot produced. Following in this corporation's example, other companies came forward requesting licenses to manufacture precast exposed aggregate concrete panels. The Pre-Con Murray, Ltd. of Toronto and Pressru-crete, Ltd. of Winnipeg, Canada, became two northern companies to lead in fabricating precast concrete under the Earley Process. That same year, Marietta merged with other companies to form the Marietta Concrete Division of Martin-Marietta Corporation in charge of all architectural products. The Earley Studio provided the aggregates and technical assistance for all plants under this supervision. The company was short-lived, however, for Martin-Marietta had to divest itself from all precast concrete plants in 1964 in cooperation with the Federal Trade Commission.

Meanwhile with the permission of the Earley Studio since 1940, the developing MoSai Associates emerged as the lead disseminating organization of the Earley Process. The MoSai Associates, which began with just seven member firms, became the MoSai Institute, increasing to 22 member firms from the United States, Canada, and Japan in 1958. These members were granted licensing to manufacture under the Earley Process, also referred to as the MoSai Process by this time. Membership funds were used for training and inspection programs, technical aids, and advertisements in national journals and trade magazines. Originally kept within the member firms, the MoSai Process has now become public.

Standard MoSai panels were usually 2 inches thick and comparably light, weighing approximately 25psf. Sizes of panels varied from 20 to 100 square

feet, the thickness of the panel was increased according to steel reinforcing design requirements.

The panels were reinforced with 4 x 4 inch; 3/8 inch diameter electrically welded galvanized wire fabric. Anchor loops consisting of 1 inch wide x 3/32 inch thick galvanized strap iron were hooked around the panel reinforcement at 2 feet intervals each way, and the loop part that projected 1 inch clear of the concrete was punched to receive the end of a form tie bolt.

The facing and backing mix were each 1 inch thick. For panels 2.5 inches thick and not less than 2 inches in thickness, utilizing a maximum of 5/8 inch aggregate in the facing, MoSai required a minimum compressive strength of 7500 psi at 28 days of age when tested by appropriately sized cubes cast from the same material. Finished units had an absorption of less than 5 percent.

Molds were typically constructed of wood, shellacked and then lined with Masonite, similar to Earley's process. The Masonite lining was given two coats of shellac, and then coated with a solution of one-third castor oil and two-thirds shellac.

Before casting, the forms were greased with a mixture consisting of one gallon of animal fat to five pounds of soapstone to prevent sticking of the casting to the mold. With this treatment the molds could be reused approximately 60 times before relining was required. After the particular form had been built, it was coated with a retarder to keep a thin outer layer of cement from setting up.

After the facing mix is placed and vibrated with a flat grate, high frequency vibrator, the reinforcement is placed in position on top of the vibrated facing, not less than 3/4 inch back of the face panel.

The reinforcing mesh is held in its proper position, that is, in the middle thickness of the panel, by small mounds of backing mix under the mesh. It was important to keep mesh in its proper position to prevent corrosion of the steel. Next, a batch of backing mix is then placed and vibrated. These panels are removed from the molds before the surface is thoroughly hardened, usually within 12 to 24 hours depending upon the air temperature.

As soon as the panel is removed from the mold, it is stacked in a vertical position on a traveling easel and gone over with an electrically driven belt sander to remove excess mortar on the face. Then, the panel is wire brushed to remove the surface mortar and expose the aggregates in their true colors. Each panel is then checked for size, trueness, broken edges, sand pockets and repaired, if necessary. Repairs are made within 36 hours of casting.

The panels are initially cured for 3 days, being thoroughly sprayed with water twice a day. On the third day, a solution of one part hydrochloric acid to five parts water is applied and then brushed off using plenty of water. The proper degree of acid etching for uniform texture is then checked under a strong light.

Next, the panels are subjected to further curing for four more days, wetting them twice daily. On the seventh day, the panels are given a final light acid wash of one part hydrochloric acid to seven parts water, except for spots that might need a stronger application to bring them to the texture of the sample. The panels are then ready for shipment.

The mixes which made up the panels were unique. For aggregates used by MoSai Associates, the Dextone Company at Redding, CT had the only crushing and grading facilities in the United States which were devoted exclusively to the production of aggregates for architectural precast concrete panels. The aggregates used in most MoSai projects had a hardness of about 7 on Mohr's scale, approximately that of carbon steel.

Average mix proportions for MoSai and Earley panels were approximately one part fines to four to seven parts of two or more sizes of coarse material. The aggregate-cement ratio was approximately four parts to one while water-cement ratio in a very damp mix was as high as 0.53, or 6 gallons per sack of white or grey cement.

The execution of designs and patterns in color in concrete required a means of preventing the mixtures from intermingling while they were being placed in the mold. On flat work or panels this operation was accomplished by: using metal strips such as that used in terrazzo, using thin strips of wood or composition which are subsequently removed and the groove pointed with colored mortar, using small ribs or fins on the face of plaster molds which leave a small V-depression between adjacent areas of color, molding recesses in the face of the concrete and afterwards inlaying the various colored

mixtures. On work carrying relief, the depressions of the mold itself provided separation of the colors.

MoSai panels by the Dextone Company were initially used as veneer for masonry construction or as a form and facing for cast-in-place concrete work.¹⁷³ (Figures 19, 20, 21 and 22)

The MoSai Institute continued their work in precast exposed aggregate cladding until the 1980s. At that point, the process of producing precast exposed aggregate concrete was published in the Portland Cement Institute's technical documents; the process that was once monopolized by the MoSai Institute was known widely used and reproduced.¹⁷⁴ By this time, the material had achieved the respect and standardization Earley had originally envisioned for it. Despite every advancement made in the field, the systematic procedure devised by Earley remains the same as it had at the beginning of the century. One 1969 article described the Earley Studio as "The Earley Studio: Bigger than ever, first US producer of exposed precast concrete adheres to same craftsmanship that brought it fame 50 years ago."¹⁷⁵

It has been shown that the Earley Process produced a durable, fairly weather-resistant building element that mid-century tests confirmed and recommended. With the continual success of the Earley Studio, the building industry understood the method's ability to create a sturdy construction element capable of producing remarkable aesthetic effects. With examples of genuine artistic craftsmanship quality, such as the Nashville Parthenon, the Baha'i Temple and the Edison Memorial Tower, manufacturers sought to reproduce Earley's

¹⁷³ Freedman. b.: 27 – 33.

¹⁷⁴ *PCI Manual for Structural Design of Architectural Precast Concrete*. Chicago, Illinois: PCI publication, 1977.

¹⁷⁵ William Blaha, "Earley Studio: Precasting's Trademark of Quality." *Concrete Products* Reprint. (July 1969): 1-6.

architectural masterpieces on a larger scale. However, as this hand-crafted process was quickly replaced by mass production, a certain part of Earley's technique disappeared, evident in the following analysis of post-Earley, MoSai structures.

MASS PRODUCTION

By the 1980s, precast exposed aggregate concrete paneling was a dominant architectural medium throughout the nation. The MoSai Process was responsible for the articulate forms of both prestigious and conventional buildings across America. However, the value in using precast exposed aggregate paneling differs from Earley's original intentions. It seems that although buildings built with Earley's "MoSai" procedure from 1960 to 1980 value the buff tone Earley used on many of his projects, these sites lack the experimentation and passionate exploration of the aesthetic possibilities in using precast exposed aggregate concrete. Furthermore, the buildings do not highlight the interplay of light, color and texture as Earley did; the use of these precast panels were overshadowed by other architectural details, such as concrete grills, spandrels and curves. The use of Earley's material and process to meet other architectural demands allowed the craft and artisan aspect of his design to disappear amid the rapid development of mass production.

Earley's intention in producing precast exposed aggregate panels was to create a uniform, textured surface whereby the specific placement of aggregates of different color would produce a desired mosaic design. This was achieved by the creation of panels - mostly rectangular in shape, that were joined together in a manner that made their connection almost disappear. Although the MoSai technique still produced the same textured surface as Earley had, the aesthetics of exposed aggregate paneling during the 1960s

and 1970s were simplified to a basic color, usually a neutral or buff tone. Mosaic-like facades were used less and replaced with generic box-like, uniformly colored high-rises, such as the Blue Cross Blue Shield Headquarters in both Boston, Massachusetts and Richmond, Virginia. (Figures 23 and 24) These buildings, although recognized as MoSai paneled structures, are highlighted for other architectural features, such as the streamline detailing of the Virginia headquarters and the corrugated design of the Massachusetts center. Earley's method was being used for its economies of design but its aesthetic potential was not fully explored.

MoSai paneling was also used as the base material to mimic modern architectural styles. When colored aggregate was used in mosaic placement similar to Earley's use, it was namely used to architecturally label a building in recessed sections of a store or building front – such as at the Wilcox Building in Meridian, Connecticut (Figure 25). This building, as well as the Dixwell Playhouse in Hamden, Connecticut, used precast architectural concrete as the building block to produce an Art Deco design. (Figure 26) Thus, the aesthetic Earley had achieved with precast units was being overshadowed by the material's ability to produce other architectural vocabulary.

Earley's exposed aggregate aesthetic was further overshadowed and replaced as new technologies in mass production allowed architects to experiment with unique shapes and patterns, leading to such ubiquitous designs as concrete grillwork and curvilinear forms. The curved concrete paneling on buildings such as the Police Administration Building in Philadelphia, Pennsylvania, and the Holy Rosary Church in Ansonia, Connecticut, were advancements in the use of concrete for their time. Scholars recognize these buildings for

their dramatic curves and shapes, sometimes unaware of the structures' use of MoSai exposed aggregate paneling. (Figures 27 and 28) Furthermore, the Philadelphia Police Administration Building was one of the first buildings to use pre-stressed, post-tensioning concrete; this greatly overshadowed the use of MoSai, which at this point was an economical building component in the construction world.

This is by no means an extensive review of the use of MoSai in mass production; however, it does highlight some of the more recognized buildings composed of MoSai (Earley) paneling, showing how these buildings do not recreate Earley's innovative use of exposed aggregate. Earley's product was seen as an economical means at achieving other architectural demands. Thus, although the building industry fully embraced the Earley Process as a technique capable of producing an aesthetic yet durable building material, the craft of the individual artisan that brought attention to Earley's projects was never fully recognized beyond the Early Studio.

CONCLUSION

Precast exposed aggregate concrete continues to be used for its economical way of producing an aesthetic surface – thanks to the efforts of the Earley Studio and the MoSai Institute. After Earley's death, his Studio continued the cause for precast architectural concrete, and the company's successful use of the Earley Process to produce a durable and architecturally innovative concrete product led to the technique's acceptance on the national level. As mass production came to replace companies like the Earley Studio in the 1970s, the Earley Process remained an integral method, practically unchanged since Earley patented it.

However, in the transition to mass production, the aesthetic opportunity, the essence of Earley's technique, had been lost. In the analysis of later MoSai structures, it has been seen that the industry, although still continuing the Earley Process, has stripped from it the hand-crafted, artisan qualities seen in Earley's works and built instead, the generic high-rise buildings seen in the latter part of the twentieth century. That being stated, Earley's work in the 1930s left two vital imprints on American architecture: the continued use of his patented Earley Process and his enduring projects that successfully combine the mass production of the Modern Movement with the artistic, hand-crafted quality of the artisan – separating these works from other precast exposed aggregate concrete structures of the twentieth century.

CHAPTER 7: PHILOSOPHICAL IMPLICATIONS FOR PRESERVATION OF HISTORIC PRECAST EXPOSED AGGREGATE CONCRETE

INTRODUCTION

Having traced the development of architectural concrete from an applied stucco finish to a shop-fabricated assembly integral to the entire building system, this chapter seeks to assess the implications of Earley's work in light of the current historic preservation movement.

This examination poses several questions. Do Earley's work and the work of his Studio throughout the twentieth century merit a place in architectural history? What qualifies the Earley work for such distinction? If these structures are worthy of preservation, how should they be preserved in accordance with the *Secretary of Interior's Standards for the Treatment of Historic Buildings*? What preservation implications do these recommendations hold for later precast exposed aggregate concrete structures? Do later MoSai structures merit the same distinction as Earley's work? The answers to these questions may, and should, arouse much debate, but they must be answered if buildings of the recent past are to be successfully preserved for future generations.

EARLEY'S LEGACY: MODERN ARCHITECTURE WORTHY OF PRESERVATION?

The preservation of the recent past creates a quandary specific of its age; namely modern architecture was a shift in material approach, architectural design and construction execution compared to its traditional predecessors. Furthermore, the assessment of modern architecture varies from earlier styles due primarily to its "newness." When it comes to the

preservation of older buildings, a process akin to “natural selection” has provided society with an inventory of surviving buildings, buildings that have “passed” the test of time due to their beauty, significance, utility or perhaps mere good fortune in avoiding catastrophic damage or the developer’s wrecking ball. However, this process does not necessarily result in the survival of the “best of the best” of buildings, as witnessed by the large number of significant buildings that no longer stand. Professionals engaged in the preservation of these historic structures are guided by an established philosophy and ethic of retention to preserve and maintain as much original fabric as possible in order to retain the values and significance society attaches to these sites. The conservation of historic buildings has been traditionally predicated on factors that relate to the importance of the site, whether it be an icon of a lost technology, the use of a natural material no longer widely used, or a level of craft and genius – factors that arbiters of history and architecture find to be significant.

However, where does this place the preservation world when professionals must work with modern buildings and modern materials? These buildings haven’t gone through the process of “architectural natural selection” nor are they likely to be made of archaic, highly crafted materials. The majority of twentieth century buildings can be pedestrian and numbingly repetitive in appearance, composed of mass-produced, composite materials manufactured using large scale and mechanized processes, stressing functionality over aesthetics – as seen in the later MoSai works of the previous chapter. Therefore, what constitutes a modern building, and more particularly Earley’s buildings, *worthy* of preservation efforts?

Many advocates for the preservation of the recent past attempt to define and provide qualifications aimed at singling out those modern buildings worthy of preservation from the collective genre of twentieth century construction. Supporters assert that architecture which defines modern heritage evokes a spirit of experimentation of the time, that the architect – through material use or design – pushed the boundaries of their field. These designers were craftsmen in their ability to creatively use the advancing technology of their time to meet their innovative ideas.

[Modern architecture] was not half as practical as it claimed to be, or as it claimed to be when it was convenient to make such claims. It was often not practical at all. Glass, floating planes, blurring the distinction between inside and outside, turning rooms from distinct entities into flowing space – you could make all the functionalist arguments you want for such things, but at the end of the day they were aesthetic choices, not functional ones. The better architects knew it. The lesser ones didn't, and used functionalism as an excuse for mediocrity, but that is not the architecture that we are talking about, by and large, when we talk about modernist preservation. We are talking about those buildings – and there are many of them – that represented a new vision of the world, a world inspired by the image as well as the reality of technology, a world of possibilities created first by the machine, and now, in later generations of modernism, by the computer. It is now much more than a century since all of these things began to create a new aesthetic, and the value of that aesthetic, not to say its beauty, ought to be beyond doubt at this point.¹⁷⁶

An important aspect of modern architecture was the use of advancing technology to create shapes and designs that would otherwise be impossible. Ten years ago, the National Park Service, in an attempt to provide guidelines for the rehabilitation and preservation of cultural sites, became the leader in outlining criteria to assess what “significant modern architecture” exactly is. The developed “Criteria for Evaluation” is as follows:

¹⁷⁶ Goldberger.

The quality of significance in American history, architecture, archeology, engineering and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, A. that are associated with events that have made a significant contribution to the broad patterns of our history; or B. that are associated with the lives of persons significant in our past; or C. that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master or that possess high artistic values or that represent a significant and distinguishable entity whose components may lack individual distinction; or D. that have yielded, or may be likely to yield, information important to history or prehistory.¹⁷⁷

With such standards already in place, how does Earley's work in precast exposed aggregate concrete fit within such criteria?

John J. Earley recognized the unique characteristics and, thus, potential, of concrete from his first experiences with it in the early 1900s. The craftsman defined and redefined the material over the course of forty years, elevating its value to unprecedented heights. His constant experimentation was based upon his craftsman's sense for the workability and potential of a material and the creative yet practical application of his techniques. His efforts led to a material that was aesthetically pleasing, efficiently produced and durable. Earley saw concrete as having two roles in the service of the building and society: the aesthetic and the durable; he addressed these roles individually and jointly, recognizing that in the end, one would affect the other. In doing so he manipulated and employed concrete's plasticity and strength in ingenious ways. Each new project challenged the Earley Studio to alter their predetermined processes to further concrete's potential as an architectural medium. The Studio abandoned the traditional mix formula; they changed the sequence of mixing

¹⁷⁷ Marcella Sherfy, and W. Ray Luce, "Guidelines for Evaluating and Nominating Properties that Have Achieved Significance Within the Past Fifty Years." *National Register Bulletin*. (Washington, DC: US Department of the Interior, National Park Service, 1998), 17.

ingredients; they varied the applied a gap-graded aggregate approach; they managed water content at different ratios during the mixing and curing stages to produce remarkable and unprecedented high early strength; they carefully selected aggregate to produce a color-permanent aesthetic; they shop-cast panels that would be able to be used both as hung cladding and as integrated formwork for structural concrete. The Studio's adaptability led to concrete's reputation for economy, flexibility, workability and endless aesthetic and architectural possibilities.

The work of Earley led to the revolutionary view of concrete as a material worthy of architectural detailing and design. The Earley Studio was the birthplace of the current precast exposed aggregate paneling industry. The production of precast architectural concrete over the past century relied on the Studio's innovations and techniques for the visual effects of non-traditional aggregates, such as glass and ceramics, in the making of large complex molds, in the precise control of concrete mix ingredients, in the casting and curing processes and in the development of novel methods for the attachment to and integration with the exterior and interior of the building.

The ideas of John J. Earley are evident in the development of his product, which holds a unique place among the history of American concrete. Recent preservation publications state that during the experimental years of concrete's development in America (1920s – 1960s), “designers and builders did not always have the experience needed to ensure successful performance. Codes of practice for design and construction were either out of date or non existent. And in some respects, notably durability and differential movement between building materials, there was a lack of understanding of the issues...

Durability in terms of steel corrosion and concrete cracking/spalling was less likely to occur if the concrete cover was thicker, denser, and less porous. Regrettably, this knowledge was, at best, thinly spread in the years after the war.”¹⁷⁸ The National Parks Service’s recent publication on preserving historic concrete cites many problems encountered with early twentieth century concrete; namely, the lack of uniformity and density that creates potential areas of weakness in terms of water penetration and ineffective resistance to weathering.¹⁷⁹ However, explained in previous chapters, Earley concrete defies these generalities. Through constant experimentation and study, Earley produced a concrete uniform both in color and texture, dense and durable. Mid-twentieth century tests concluded that Earley concrete was always around 5000 psi – now in place as the standard but unheard of in Earley’s time. Furthermore, Earley’s projects have stood the test of time with restoration campaigns only being necessary in the last decade of the twentieth century, and the analysis of the deterioration of John J. Earley concrete at these sites has determined that failure mechanisms generate from the lack of knowledge at the time in regards to reinforcement coatings, jointing and sealing – factors independent of Earley’s concrete mix. Exposed aggregate surface finishes are still recommended as highly weather-resistant and durable exterior finishes for concrete,¹⁸⁰ – thanks chiefly to the workings of John J. Earley.

Based upon this analysis, it can be stated that John J. Earley concrete is in direct accordance with Paul Goldberger’s definition of modern architecture; namely, the works of John J. Earley and his Studio represent “a new vision of the world, a world inspired by the

¹⁷⁸ Ibid, 99 - 100.

¹⁷⁹ Paul Gaudet and Deborah Slaton. “Preservation of Historic Concrete.” NPS Preservation Brief 15. Washington, DC: Department of Interior, 2007.

¹⁸⁰ Panarese, William C., Albert Litvin, and James A. Farny. Performance of Architectural Concrete Panels in the PCA Outdoor Display. Skokie, IL: PCA Publication, 2005.

image as well as the reality of technology.”¹⁸¹ Similarly, Earley’s work fits within the “National Register Criteria for Evaluating and Nominating Properties that Have Achieved Significance Within the Past Fifty Years” as “distinctive of a method of construction...that represent[s] the work of a master [and] possess[es] high artistic values.”¹⁸² Earley works are distinct moments in architectural history – as examples of both the artistic development of precast concrete and the use of technological advancements and experimentation of the time. As explained below:

John Earley unveiled the potential for use of exposed aggregate concrete as an architectural finish material. Yet, what John Earley established was not a single architectural finish, but a family of techniques to create a vast range of forms, colors and textures with concrete materials. Using innovations in production methods, he met increasing challenges with breathtaking results... Each of John Earley's techniques produced high quality finishes. Each technique offered advantages for different situations. Any one technique could be described as inventive. But in their total effect, John Earley's innovations breathed life and spirit into concrete as a modern architectural material.¹⁸³

REPAIR, RESTORE, REPLACE?

Now that it has been established that structures created by John J. Earley and the Earley Studio are worthy of preservation – in accordance with the definition of “significant modern architecture” – how preservationists approach the restoration of these sites must be explored and defined. Since the mid-twentieth century (when the preservation of cultural heritage became regulated by federal, state and local legislations), advocates for historic

¹⁸¹ Goldberger.

¹⁸² Marcella Sherfy.

¹⁸³ Robert Armbruster. “Earley’s Studio’s Innovations Create a New Architectural Material.” Unpublished Paper. 2001: 1, 15.

buildings have generally applied a single preservation strategy and philosophy; *The Secretary of the Interior's Standards for the Treatment of Historic Buildings* became the universal guidance against which restoration and preservation efforts have been and are measured. With that said, how can this guidance and philosophy be applied to John J. Earley's precast exposed aggregate concrete panels?

Above all other recommendations, the guidelines' *Standards for Preservation* stress that "the historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided."¹⁸⁴ If possible, the actual physical remains that make the architecture worthy of preservation must be saved and maintained. Furthermore, "distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved."¹⁸⁵ Thus, if followed literally, this policy would deny the replication and replacement of precast concrete in order to retain the original, historic Earley fabric. However, Earley's ultimate goal was to create an aesthetic permanence of exposed aggregate concrete uniform in both color and texture. Therefore if the deterioration of Earley panels is to the point where the aesthetic quality of the work is jeopardized, the overall importance of Earley's work would be diminished. Accordingly, the panels should be replaced.

The *Standards for Rehabilitation* continue to explain other alternatives if the first principle cannot be accommodated.

¹⁸⁴ W. Brown Morton, III, Hume, G.L., Weeks, K.D., and Jandl, H.W., *The Secretary of the Interior's Standards for Rehabilitation and Illustrated Guidelines for Rehabilitating Historic Buildings*, (Washington, DC: US Department of the Interior, 1992), no. 2.

¹⁸⁵ *Ibid*, no. 3.

Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.¹⁸⁶

These statements recognize that retaining original fabric might not be practical or possible in every case; therefore, repairing the materials is recommended when restoration is not an option; and replacement when restoration nor reparation is an option.

The question over “restore, repair, replace” of precast exposed aggregate concrete also elucidates another philosophical debate: that of “authenticity.” When it comes to the restoration of cultural heritage, the *Venice Charter* urges preservationists to maintain “the full richness of their authenticity.”¹⁸⁷ However, what exactly does the term “authenticity” mean?

John J. Earley understood the time factor in building durability. In his writings he spoke on the permanence of his concrete as being only as durable as the most durable historic buildings with the understanding that time ages all construction. For the Baha’i Temple, which was meant to be a lasting monument, tribute to enduring religious faith, Earley devised a method of construction that would be convenient for later replacement campaigns if needed.

We have arranged the temple dome so that any piece can be repaired and, if need be, removed and replaced without disturbing any other piece. Furthermore, if the furring system through neglect should deteriorate to such a condition that it were advisable to replace it, it can be moved and replaced without disassembling the concrete dome. In deed it would be presumptuous

¹⁸⁶ Ibid, no. 6.

¹⁸⁷ ICOMOS, International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter), (Venice: ICOMOS, 1966).

to attribute to the steel structure and the concrete envelope an endurance greater than they can possibly possess.¹⁸⁸

Based upon his writings, it can be concluded that if the deterioration of Earley concrete has deterred from Earley's intentions of producing an aesthetically-appealing material, he, himself, would recommend replacement.

Replacing John J. Earley concrete poses a difficult question, given today's mass production use of the Earley Process seen in the previous chapter. It has already been defended that today's use of the Earley Process diverts from John J. Earley's original intentions. Therefore, replicating Earley's material must use the Earley Process as implemented by Earley himself. This can be accomplished through the careful study of the Earley Studio, and although the materials can be mass produced today, those in charge of replicating Earley's work must understand how they may be able to best combine the machine made panels with the delicate, craftsmanship of Earley's technique.

The recent restoration campaigns on Earley's works have successfully carried out these recommendations; after intense research, study and testing of the original concrete, exact replications have been made and employed on Earley sites. During the restoration of the Nashville Parthenon, in particular, project managers studied Earley's writings and trained the concrete restoration contractors in the Earley Process. The restorers, once educated in the Earley Process, successfully replicated the Earley Studio's work – an idea Earley, himself, encouraged in the training programs he established in the 1940s.¹⁸⁹ However, sometimes

¹⁸⁸ Earley, John J. "Architectural Concrete of the Exposed Aggregate Type," 256.

¹⁸⁹ Correspondence with R. Armbruster. 10 April 2008.

compromises must be made; when the budget could not afford the expenses for exact replication, “an alternate concrete formulation was employed for complete replacement of areas while exact replication concrete mixtures were employed for patching and partial replacement.”¹⁹⁰ Therefore, to proceed in accordance with the *Secretary of Interior’s Standards for Rehabilitation*, when restoration or reparation is not an option, replacement is an appropriate recommendation in order to fulfill Earley’s original intentions.

Thus, authenticity, as it applies to Earley precast panels, is more about the process of production than the original Earley fabric. Earley created beautiful and durable panels, but his legacy still lives on in the techniques he mastered and patented – those techniques that are still being used today. The authenticity of his work lies in the technological value of his craftsmanship as well as its artistic/aesthetic value. This notion of technological value – in terms of using the Earley Process to recreate panels – is a vital part of values-based preservation that is most often overlooked in preservation campaigns. However, it cannot be ignored in Earley’s work and becomes a fundamental aspect of how these works are valued and preserved.

HIGHLY-CRAFTED EARLEY VS. MASS PRODUCTION OF TODAY?

The value of John J. Earley’s work resides in the processes he developed, patented, shared and standardized, in the physical fabric he left behind, *and* in the precedents he set for construction materials of the Modern Movement. In his forty year career, Earley explored the aesthetic possibilities of a bland construction material and sought out its weakest properties, determined to develop techniques to resolve those weaknesses. He advocated

¹⁹⁰ Ibid.

universal production standards to achieve consistent quality in production. As a result, the material and methodologies had been fully developed and accepted by the construction industry in time for the post World War II building boom in the United States, a boom which coincided with the Modern Movement. In coining his technique in reference to the art of producing mosaics, Earley immediately recognized the Modern Movement's idea of "playing" with building materials and experimenting with their ability to express an architect's desired aesthetics. In patenting and later publishing and sharing his work, Earley initiated the professionalization and standardization of producing and applying precast exposed aggregate concrete. Today, this material is mass-produced within the Studio's framework of techniques and standards.

Production of modern architectural concrete has required the Studio's innovations in model making, in mold technology, in control of water over time, and in casting with multiple mixtures. The precast architectural concrete industry has been built upon Earley Studio's methods of surface finishing, reinforcing, connections, joints, transportation and installation.¹⁹¹

Finally, through continual efforts, Earley led the field's revolutionary approach to material studies and design; it was through him that architects of the AIA and material scientists of the ACI formed a mutual cooperative to develop and fashion building construction that would later dictate the latter part of the twentieth century in America. Future efforts of this collaboration led to the standardization of construction practices, which included materials inspection and quality assurance contracts. Today, samples of all materials must be tested and building components must be inspected before erection in

¹⁹¹ Robert Armbruster. "Earley's Studio's Innovations Create a New Architectural Material." Unpublished Paper, 2001: 15.

order to ensure superior quality – practices Earley established before there were mandates that required them.

The work of John J. Earley and the Earley Studio provided the aesthetic and techniques that enabled the birth and expansion of today's precast architectural concrete industry. Therefore, as the father of these techniques, Earley's work holds specific technological value within the history of American architecture, and thus, is worthy of preservation efforts. However, what can be said of precast exposed aggregate concrete buildings influenced by the Earley Studio? Is the use of Earley's techniques a justification for a building's preservation?

The modern era saw the construction of more buildings than any other period of time in American history; due to its durability and facility in construction, precast exposed aggregate concrete cladding became a staple during post-war construction. However, it has been shown that post-Earley use of Earley's process took ample use of the economies of his design without realizing the full potential of its aesthetic possibilities. The MoSai Process was a cheap means of creating large expanses of predefined concrete panels used to meet other architectural designs. Therefore, the use of precast exposed aggregate concrete cladding as defined and produced by the Earley Process may not be the primary reason for the preservation of a post-war building. However, the Earley Process of developing precast paneling was – and still is – an economical solution to produce a durable and aesthetic surface. This combination of durability and aesthetics may be another facet used to fight for a modern site's preservation and adaptability.

CONCLUSION

When it comes to the preservation of modern heritage, technological value and durability must be acknowledged within current preservation philosophy. The twentieth century was a time of tremendous experimentation and industrial advancements, and the work of the Earley Studio was no exception. John J. Earley experimented with developing methods and technology to develop a new role for concrete in the architectural world. Not only did his techniques advance the reputation of concrete as an architectural medium, but he refined his process to meet challenges of durability, form and application that are still being used today. Therefore, the importance of Earley's work lies not only in the structures he created that stand as examples of his superior craftsmanship and ingenuity, but in the Earley Process he left for generations to follow.

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Figure 2. Meridian Hill Park, Washington, DC. Courtesy of the National Park Service Website. <<http://www.nps.gov/mehi/>>, Obtained April 2008.



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Figure 6. Nashville Parthenon. Courtesy of the Nashville Parks and Recreations, < <http://www.nashville.gov/parthenon/>>. Obtained April 2008.



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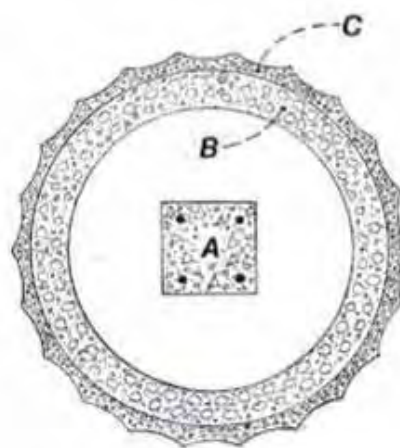


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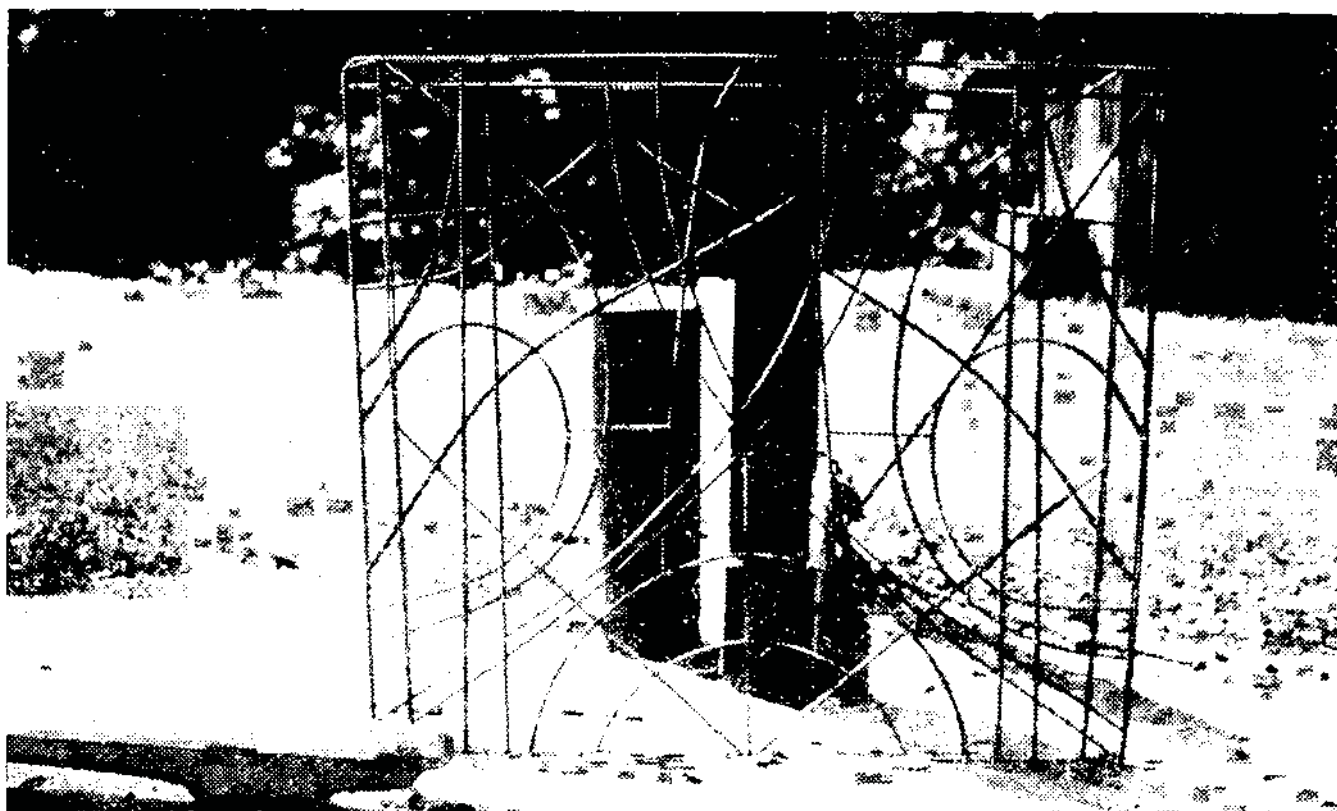


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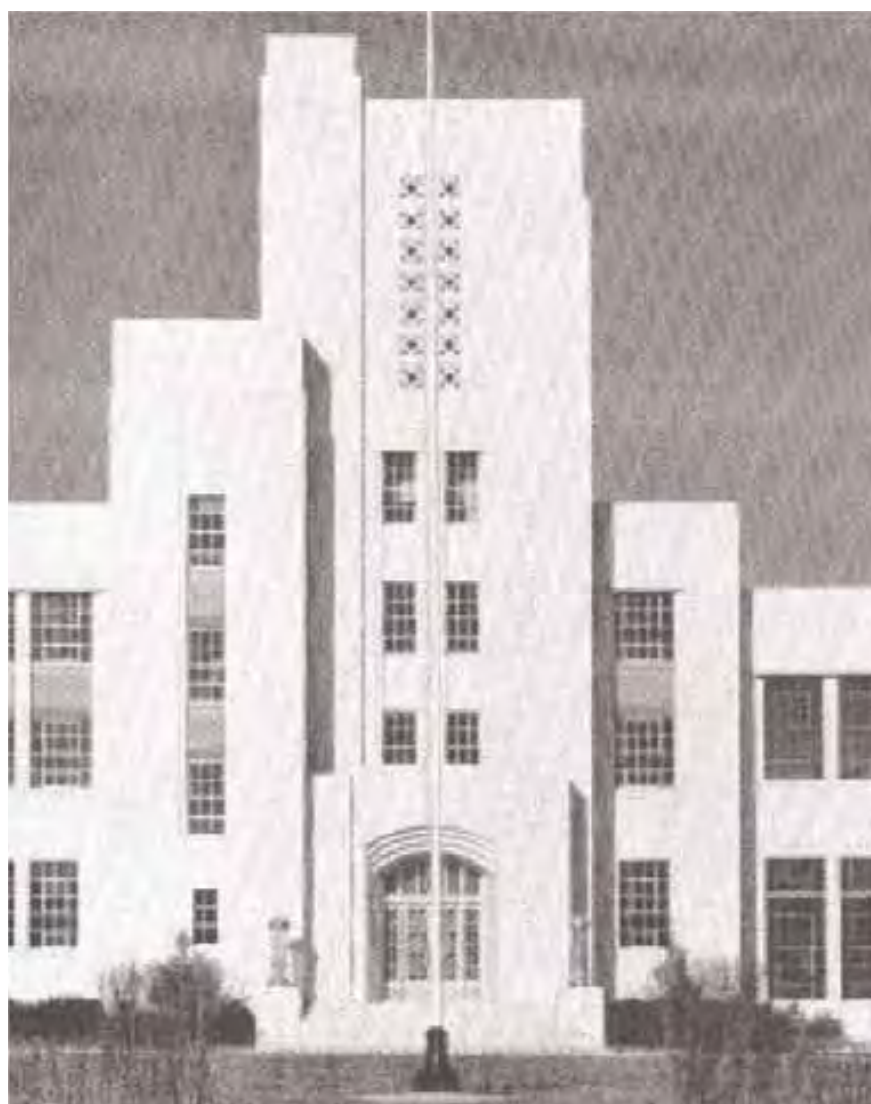
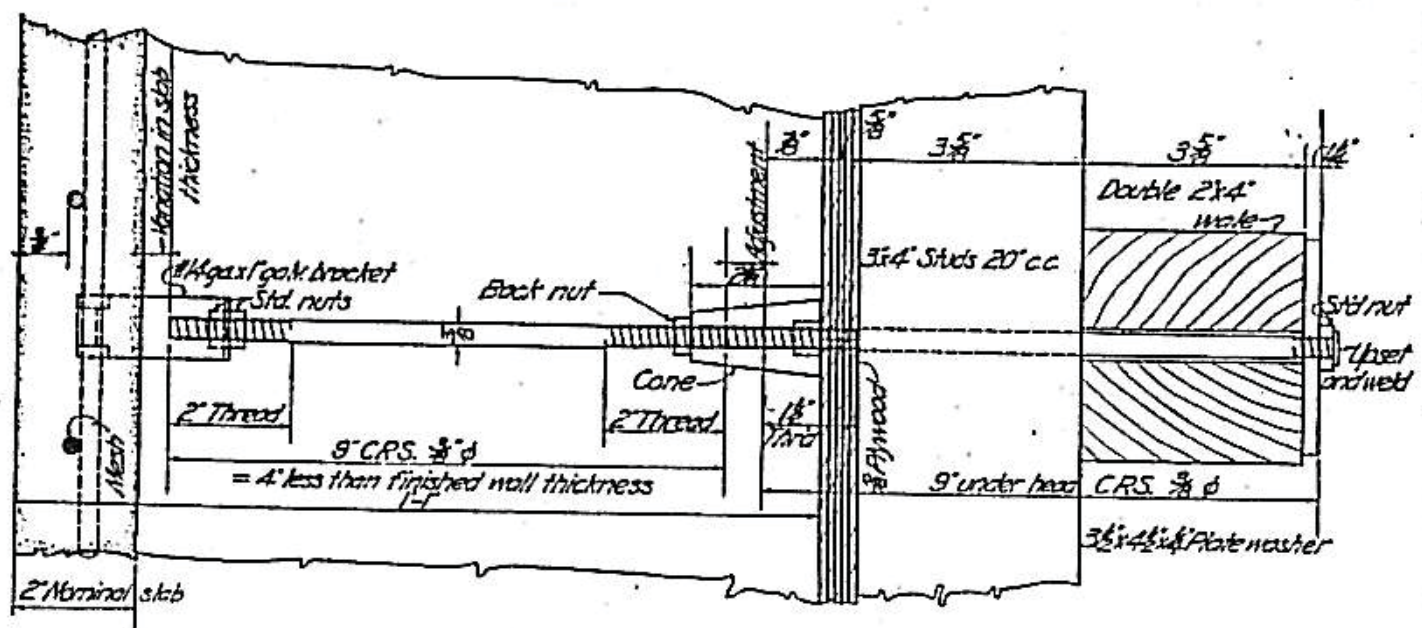


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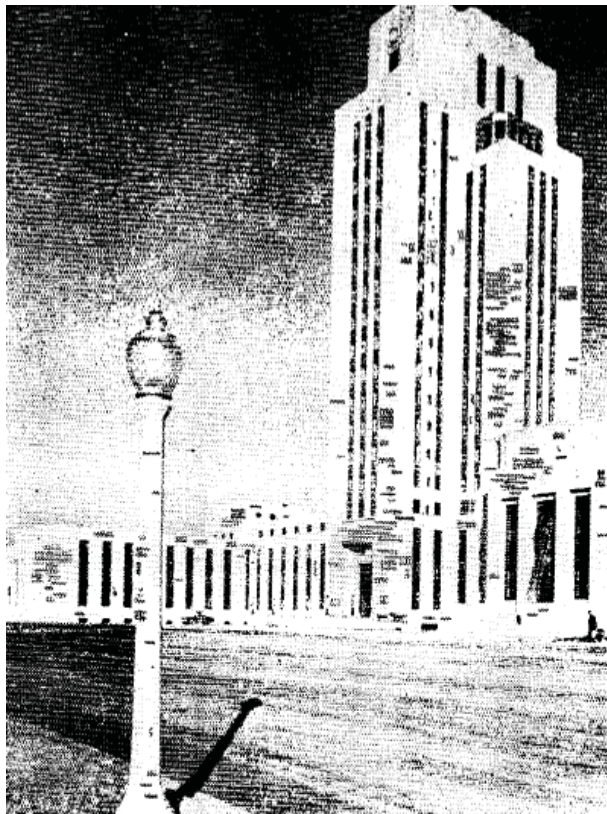


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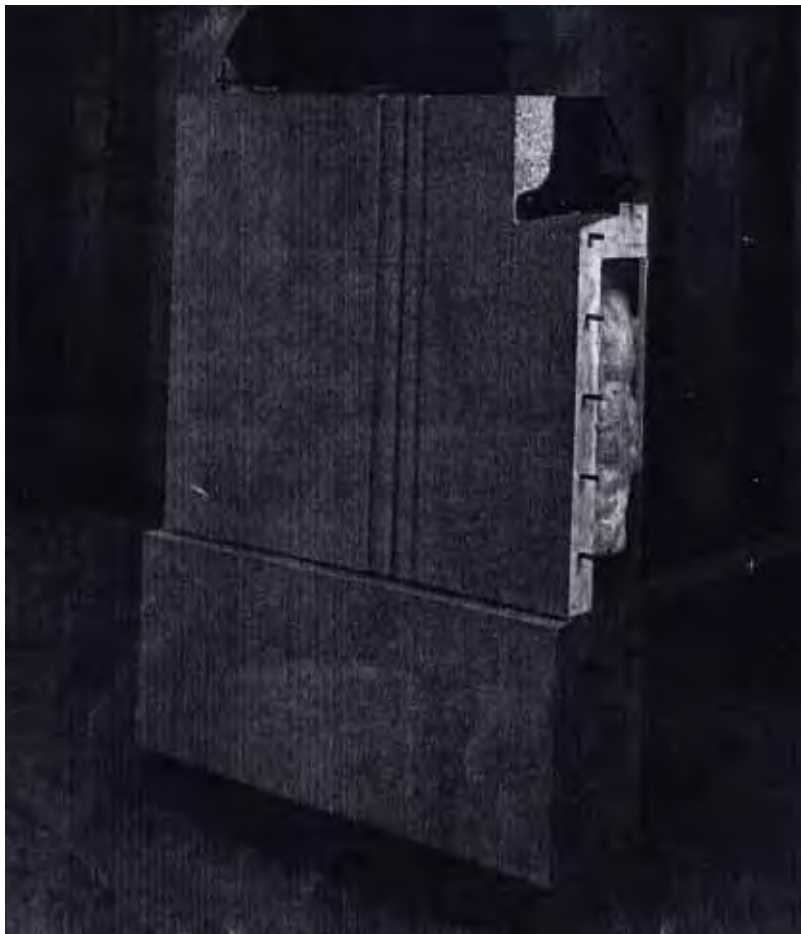


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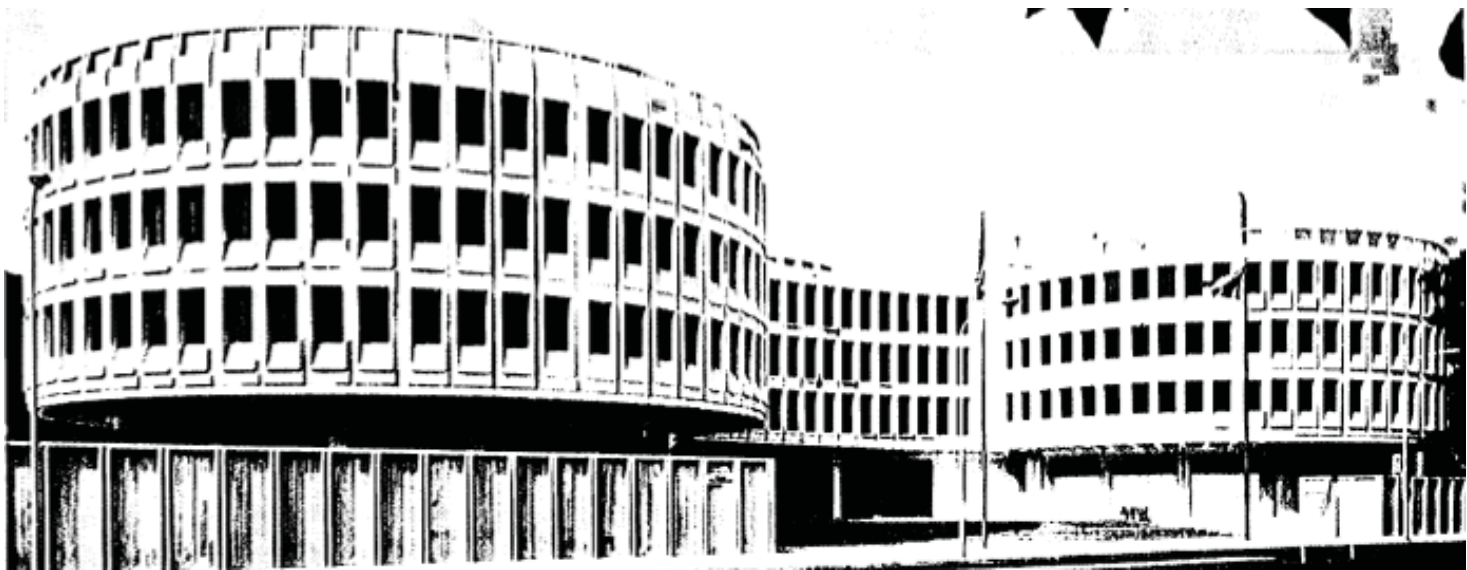


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